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THE RISE OF PREVENTIVE MEDICINE

UNIVERSITY OF LONDON
HEATH CLARK LECTURES, 1931
delivered at
The London School of Hygiene and Tropical Medicine

The Rise of Preventive Medicine

By

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IN MEMORIAM

CHARLES HEATH CLARK

MR. Charles Heath Clark was born at Southampton in 1860, but he spent his working life in Birmingham, Croydon, and London, and died at his country home in Sussex in 1926. He became the head of a great business enterprise in London, with branches in various parts of the world, which made many claims upon him.

Yet the chosen occupations of his leisure seem to have been hardly less clamant. He was a public-spirited man who devoted himself to the service of his fellow men—in education, particularly that of the adult, in municipal and health work, in support of the League of Nations, and on behalf of the welfare of young men. It is not too much to say that he called his generation to the enduring virtues of reliability, uprightness, and virility. Nor did this task seem in any way self-imposed. For this prince of business men had a resilient and radiant character, which somehow appeared to furnish him with a charmed life of noble visions. He seemed innately to possess the integrity, gravity, capacity, and wisdom extolled by Cicero. He had an unselfish public spirit of wide catholicity, exercised without ostentation, a persistent diligence which was apparently a continuing pleasure, and, it must be added, something of a genius for friendship. It is not surprising that such a man, though claiming no disciples, won the devotion of his friends and became a power in their lives.

After his death it was found that he had left substantial Trust legacies in the interest of public health and education. The foundation of this lectureship in the University of London is one of these bequests. The Senate have resolved that the general scope of the lectures is to include the educational, cultural, and humanistic aspects of Preventive Medicine as distinct from the technical and manipulative training essential to its practice and progress. In a word, the objective is to be the wider outlook on the physical art of living, the advance of personal hygiene, and the origin and

development of Preventive Medicine and its sanitary and social evolution, both in temperate climates and the tropics.

Mr. Heath Clark had little or no interest in university study merely for the purpose of passing examinations. His concern was with the enlightenment of the mind and heart, with the relief of suffering, and in particular with the two-fold need for raising the health standards of a democratic people, and providing them with an education qualifying them for wise governance. His benefactions were therefore directed to the promotion and exploration of truth, and the extension of the frontiers of life.

I trust that many distinguished exponents from various parts of the world will stand in this place in the years to come and be the competent interpreters of the culture of medical science for the betterment of man's estate. Thus may they fulfil Mr. Heath Clark's desire that human life may be prolonged and enriched by a more liberal understanding of natural law, of the greatness of the world, and of man's mind.

PREFACE

WHEN I was honoured with the request to deliver this first series of Heath Clark lectures of the University of London it seemed appropriate that I should attempt to offer a general and introductory bird's-eye view of the subject of the origins of Preventive Medicine. From a field so extensive it was not practicable to select more than certain particular aspects and themes which seemed to me of importance, leaving others untold. These lectures do not profess to constitute a complete text-book of their subject. They are rather of a preparatory nature.

If any of my readers consider some of my subject-matter to be remote from, or irrelevant to, the immediate issue under discussion, I would invite them to reflect upon the fact that the scope and setting of Preventive Medicine is as wide and universal as human experience has made it. It is concerned not only with one branch of the art and science of Medicine but with various ramifications of social, political, and religious circumstance. The ideal of Medicine is the prevention of disease, and the necessity for curative treatment is a tacit admission of its failure; yet the ways and means of prevention, from the earliest times, have constituted a part of the history of human conduct in the individual and the community rather than being merely instruments of the medical art. Many non-medical factors and influences lie at the basis of Preventive Medicine. It may, I suppose, be added with truth that human survival and the cultivation of human health and capacity have always been, consciously or unconsciously, among the first and most fundamental tasks of statecraft.

Instead of acknowledging my obligations by references in footnotes, I have added a brief bibliography at the end of each lecture.

G. N.

March, 1932.

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I

FOLK-LORE, MAGIC, CUSTOM, RELIGION

'*First sense a truth, then rationalize it.*'—GOETHE.

Synopsis of Lecture I

The conception of Preventive Medicine: curative medicine, preventive medicine (individual and communal), constructive medicine (hygiene). Necessity of research.

The sphere of hygiene includes '*everything in the collective life of humanity which affects health.*'—Sudhoff.

Folk-lore the beginning of the science and art of Medicine.

Forms of social organization, and its customs, purpose, and culture.

Its protection against crises: (*a*) routine crises: birth, initiation, marriage, death; (*b*) not routine: hunger, accident, sickness, war.

Early beliefs as to causation of disease (human, subnatural, supernatural, natural).

Magic and its derivatives.

Primitive prevention and treatment of disease:

(*a*) domestic (examples),
(*b*) demonology and astrology,
(*c*) specific magic ('*man's own power*'—Rivers).
Animal, vegetable, and mineral remedies; the serpent, reasons for its adoption; healing waters; the evil eye; names and numbers; girdles.
(*d*) Divine healing ('*Some power in the universe greater than man*'—Rivers).

The Medicine-man and his pouch; the priest and his ritual and incantations.

Primitive Religion and Medicine. The healing gods of the ancient world. Man faced with the unknown and the inscrutable, or with unfulfilled desire, bethinks himself of his gods. '*Religion fulfils at vital crises an indispensable function in the scheme of human culture.*'—Malinowski.

The contribution of folk-lore and magic in Preventive Medicine.

I

FOLK-LORE, MAGIC, CUSTOM, RELIGION

We may define the subject of Preventive Medicine as that branch of the science and art of Medicine which is concerned with the preventive aspects of the healing art as distinct from its curative function. For though in practice the two cannot be separated each represents in varying degree a different specific purpose. The avoidance of disease or its infection, and the prevention or reduction of its sequelae, are obviously not identical with its remedy or cure.

It may be said that the science and art of Medicine may be differentiated as threefold in aim: first, there is the universally accepted idea of Medicine as the provision of a remedy or cure for what we conceive to be disease (*Curative Medicine*); secondly, there is the avoidance or the prevention of its infection or causes, and, when it be initiated or established, the prevention, reduction, or modification of its results or of disease-producing factors (*Preventive Medicine*), which may concern individuals, or may be directed to the protection of the community and the improvement of its external environment, and thus be concerned with the Public Health; and lastly, there is the study and practice of a way of life which conserves the natural defences of the individual or the community, a protection against disease associated with a favourable external environment (*Conservative Medicine*; *Constructive Medicine*; or *Hygiene*). As we shall discover in due course, around these three aspects of Medicine mankind has designed, invented, or organized vast schemes of amelioration or defence for its own survival. Though the purpose of such plans is declared, or is a matter of common knowledge or experience, its fulfilment in practice inevitably and appropriately overlaps other purposes, and may be at one and the same time curative, preventive, or constructive in tendency. When we come, subsequently, to consider in what disease actually consists we shall find that it is a natural reaction of the body, mind, and spirit of

man to his total external surroundings, and the complexity of its control will become as obvious as the width of its scope. Even in relation to the individual the ramifications involved in the cause and prevention of disease are manifold. How much more so in a community, a nation, or the human race.

The object of these lectures is to consider the origin and rise of the art and science of Preventive Medicine, and to do this necessitates some exploration into its history. This is what Professor Karl Sudhoff of Leipzig says:

'The historian of hygiene should not be satisfied with what has been realized or even planned in the field of hygiene. The subjective factor in hygienic work of the past should in no wise constitute the sole, let alone the decisive, view-point of the historian. Everything in the collective life of humanity, which has from the beginning affected the health of the individual or the race for good or evil, must be considered and closely examined with regard to external and internal conditions of life, to commission and omission, to work and thought, to customs, laws, and religion. The history of hygiene begins therefore with the primeval history of mankind. . . . Our subject is a part of the history of culture, and a part of the history of the human spirit similar to, and yet different from, the history of Medicine itself. The history of hygiene skirts with intention great areas of cultural activity. . . . It will be necessary to make a comprehensive investigation of the external conditions of life among all ancient peoples from hygienic view-points, and here it becomes most apparent that the history of hygiene is in reality a new science, that might even be considered a novelty. The relations between Medicine and Religion are for the most part of a hygienic nature. . . . Dwellings, settlements, food, clothing, the care of the body, sexual relations, the disposal of the dead, must all pass in review before our eyes, if we are to gain the true historic view-point. Over the whole world the historian of hygiene must diligently and faithfully follow up the researches of the historian of culture and the work of archaeologists with that sense of values which the modern hygienist cannot be without. . . . He can stop at the pillars of Hercules just as little as the Phoenicians. He must cross the sea with Columbus, Magellan, and Cook to distant coasts, where novel hygienic questions find novel and significant answers.'

This noble and suggestive passage carries us far afield into the great wide spaces of time and thought, to magic and

pestilence, to medicine and surgery, to sanitation and medical polity, to culture and religion, on the Euphrates and Tigris, and in the Nile Valley, in Greece and Crete as well as in the Roman world. We must be students of archaeology, anthropology, sociology, and biology. Above all must we study the science and humanism of history. For the triumphs of Preventive Medicine are, as we shall see, among the greatest achievements of the mind of man.

It is quite evident that no attempt can be made to cover this vast field. We must be content to discuss in an introductory manner some of the chief landmarks by which our present knowledge of Preventive Medicine may be illustrated or its origins explored.

Folk-Lore and Social Organization

In order to begin at the beginning we have to go back in the experience of men long before the days of law, organization, and science to the primitive times of *folk-lore*. For it is by means of folk-lore that we learn of the earliest customs and legendary traditions which prevailed before there was written language—and which prevail still. Something of the primeval man lurks in us all, and its 'survivals' constitute custom from age to age. Thus folk-lore is universal, varied, not the monopoly of any period or nation or race, rooted in man, in his needs, his observations, his instincts. It is not only a channel of communication from one generation to another, but it is itself a custom, composed of and converging in tradition, magic, wonder tales, witchcraft, sorcery, superstition, religion. At first theurgic and mystic, it becomes in some degree rationalized, and upon it a superstructure of belief, reason, and culture has been built. Indeed, the study of folk-lore has shown that it possesses, with all its traditional variation, imagination, and insecurity, a substantial measure of organic unity and solidarity revealing an essential similarity in origin and in tendency. It is indeed ultimately rational. 'It is', as Sir Clifford Allbutt said, 'the beginning of the science and art of Medicine.'

Folk-lore has been studied by various travellers and investigators and in many lands. Some have collected specimens, and have sought to relate and classify such examples in the hope of formulating general principles. Others have attempted to trace the remote historic and racial survival of customs down to our own day, or alternatively have traced the custom of the present back to its original source. But experience has shown that the best method both of exploration and interpretation of folk-lore is the study of the primitive *forms of the social organization of human society*, first by an examination of its institutions and then by a corresponding study of its subjective beliefs, 'working up to the beliefs', as Dr. Marett advises, 'by way of the institutions'.

'First, the institution should be examined as so many wheels in a social machine that is taken as if it were standing still. You simply note the characteristic make of each, and how it is placed in relation to the rest. Regarded in this static way, the institutions appear as "forms of social organization". Afterwards, the machine is supposed to be set going, and you contemplate the parts in movement. Regarded thus dynamically the institutions appear as "customs".'

This, the 'functional method' of approach, is designed to discover how and why the forms of social organization have come into being. Custom, tradition, superstition, magic, sorcery, and religion have all some reason or experience at their back, and all are organically connected with the rest of culture—the simple and primitive with the complex and elaborate. The object of inquiry has been to establish this characteristic and this mutual relationship. The functional method insists on the organic unity of the living whole of folk-lore rather than the decipherment of a loose and unrelated collection of anthropological curiosities; it is not primarily concerned with the controversy as to whether folk-lore is a process of special biological evolution or whether it is diffused from race to race or country to country. The objective of the functional method is the *meaning* of a cultural process, which is living, dynamic, and purposive, and which reveals the intention and motive of

its users as well as the underlying 'laws of the functional correlations of anthropology'. This is what Malinowski says:

'The functional method, by showing what culture does for a primitive community, establishes its value and thus utters a warning against too hasty interference with native belief and institutions and too wasteful an exploitation of native labour and resources. By demonstrating how primitive custom and law work, it furnishes the administrator with practical hints of how to frame and administer native regulations. By inquiring into savage economic organization, the functional method can teach how to manage indigenous labour and how to trade with the natives. By a sympathetic study of early belief and ritual, it can instruct the missionary how to graft a new creed upon the old one without destroying what is good and sound in it.'

But this kind of search in the dark after a cultural process, or what may become such, is more than immediately utilitarian. It suggests, in lieu of flight or escape, an organized form of prevention as a defence against disease and the hazards of other enemies of mutual aid. Malinowski continues in these words:

'The facts of social organization impose certain conditions upon human behaviour, imply restrictions and create new wants, which again call forth specific cultural arrangements. Thus, higher forms of organized labour need some compulsion, supplied by political inequalities, and some moral framework, supplied by certain forms of magic.

'Mental development running side by side with higher technical ability brings about fear, thought, and reflection which make man anticipate his destiny and probe into the past and future of his world. The beliefs of primitive man about future life, the beginnings of the world and spiritual powers, have to be correlated with his increasing mental outlook as well as with the widening social horizon and the development of cultural values. Social cohesion requires some means of enforcing the various rules imposed upon the individual for the common good, and this brings about the sanctions and inducements which constitute the essence of primitive law. In all this the functional view avoids the effort of attributing priority to any one aspect of culture. Material objects, social grouping, traditional and moral values, as well as knowledge, are all welded into a functional system. To explain any item of culture, material or moral, means to indicate

its functional place within an institution, which has to be thus explained with reference to its aspect and this again has to be placed within the system of culture.'

Now whatever group of mankind we select, and at whatever historic period or geographical site, its social organization or institution is the result of a complex of factors. Among them are race, climate, locality, history; animal instinct, emotional impulse, 'behaviourism', or designed plan; occupation and state of general culture; magic, superstition, religion. But at the back of all, and the beginning of all is *the instinct of survival*. The primitive group and the civilized group are identical in being moved by profound impulses springing from this instinct. These impulses are derived from the physical and mental nature of man himself, from the evolutionary history of his body and mind, from his kinship with human and animal species, from his fear of discontinuity. It is the existence in man of these deep-rooted impulses, desires, emotions—call them what we will, and whether they be conscious or unconscious—which anchor the bed-rock principles of Preventive Medicine in anthropology, the science of the biological history of man.

We shall find these elemental impulses unveiled in folk-lore, in magic, in the superstition and religion of primitive man, as we shall find them in Paris, London, or New York, in the vast rural populations of the East or in the industrial communities of the West. We may briefly consider four of them: *the Food quest*, *Sex and marriage rite*, *the Number of the group*, and *the Customs of the group*. These are not only the four chief factors which give form and character to the social organization of human society, but they represent the principal problems which first arrested the minds of men as they reflected upon the well-being of their kind, and directed them to means of solution. It is clear that these four factors are intimately associated and interrelated. Around them controversy has flourished. Some would say with Dr. Marett that 'culture depends on social organization; social organization on numbers; numbers on food; and food on invention', and there is much to be said in favour of this sequence. Others would claim that com-

mencing with the Garden of Eden food and sex come first, to be followed by increased population and the development of custom and social organization, a succession which could also be supported by reason.

The point for us to bear in mind is that in these four features of the communal life of primitive man, both as he existed thousands of years ago and as he exists to-day, we have the fundamental problems which gave rise to the art of Preventive Medicine.

Let us consider them for a moment. If man desires to live he must eat, and satisfy the instinct of hunger. He must acquire and accumulate food, whether he obtain it by exchange, barter, or battle; and he must do this, whether he likes it or not, if he would create potential capital for his own pleasure, for his survival and security, or for the acquisition of any enduring culture. Again, if he would either carry on his species or enjoy the amenities of human life he must fulfil the function and instinct of sex; and if he would do this wisely, and not only instinctively, he must be, in the modern sense, eugenic. Out of the sex function in early man there sprang the vital business of marriage, the family, consanguinity, and its sociological expression in kinship (with its exogamy or marrying out, its lineage, and its totemism). And out of these beginnings arose the phratry, the clan, the tribe, the nation—and property, local government, defence, and law. Again, the survival and increase in population of the prosperous groups and the decrease of the less prosperous raised the whole acute problem of numbers, their sustenance, occupation, good ordering, equipment, and defence. Then, as now, there was an optimum population which could be sustained and protected to the satisfaction of the community or its Chief. Then, as now, population was restricted by famine, disease, emigration, or war. Then, as now, population per acre was one of the supreme practical issues of existence. Lastly, there was custom, and custom is always enthroned. What has been done should be done, particularly if the custom be one based upon food quest, sex function, or defence and their derivative institutions. Exogamy, lineage, and totemism

originated the primitive family, and around it was developed the provision of defence, of partnership, and of co-operation for the general good. 'Initiation' introduced youth to tribal responsibility as magic did to religion.

Let me halt for a moment to remind you that this 'functional method' of investigation in anthropology is of supreme importance to us. It lies at the root of any true understanding of Preventive Medicine. It is indeed the supreme method of the sort of scientific inquiry which we must pursue unremittingly. For it means that in all our search and research we must first collect and verify our facts; then we must classify our facts in accordance with their individual origin and their true function and purpose, *why* was this or that custom performed; thirdly, we may draw our deductions and formulate our conclusions; and lastly, we must so to speak standardize our deductions by our total experience, subjective and objective, correcting them by the plumb-line of scientific and historical knowledge. In his *Life of Roger Bacon* Dr. Bridges said, 'his aim was induction leading to deduction, in order to construct'.

Such being the foundations of primitive social organization, we must turn to consider its protection or safeguard against critical happenings, or its means of meeting unforeseen situations. Such *crises* for the individual or the primitive community fell, generally speaking, into two groups. They were routine, foreseen and prepared for; or they were exceptional and to be met by exceptional action. As examples of the former may be mentioned Birth, Initiation into the group or tribe, Marriage, and Death, and for these four crises in the life of the individual custom prescribed a religious ritual from which there could be no departure. The crises which were unforeseen and had to be met, if and when they arose, were Hunger, Accident, Sickness, and War. It is with sickness and disease that we are concerned.

The beliefs of mankind as to the causation of disease were investigated in our own time by Rivers, the Cambridge anthropologist, who classified them in three groups. In the first group were diseases of human origin, an act of some angry human being, dead or alive; in the second group

disease was attributed to a malign influence of subnatural (animal) or supernatural (spiritual) origin, a non-human agent, demon or deity; and a third group of the causes of disease were believed to derive from natural sources.

Until recently the first two groups covered the majority of beliefs. Sickness was a visitation from some occult source outside the realm of Nature, and presumably inflicted on the individual as a penalty for sin or some specific infringement of recognized custom. Rivers and Hocart have shown that in the Solomon Islands disease is attributed to infringement of taboo, of totem, or of the rites of the magician, a view of causation still prevalent in some degree among the majority of mankind. The races of men who believe that sickness is occult or a penalty predominate over the races who recognize in disease the operation of the natural law of cause and effect. They hold that the means and occasion of disease as well as its forms may vary, but the principle remains. Although generalization is not yet permissible the data collected hitherto suggest that the malign influence operates in different ways according to race.

For instance, in Australia, Melanesia, India, Africa, and North America numerous examples have been found of the belief that disease is produced by some morbific substances being added to the body—a crystal, a stone, a bone, leaves.

In Australia were also found examples of the belief that disease was the result of abstracting something from the body—kidney fat, fat of omentum, or 'spirit'.

In Melanesia, Indonesia, and North America the malign influence was often exerted by a sorcerer who concentrated it upon some definite part of the body, such as a ray of light directed upon the brain or the heart, and in Guinea the 'soul substance' might thus be injured or morbidly affected. Similarly a sorcerer could select individuals or families as victims of infection.

Magic and its Derivatives

Be the cause of disease what it may the universal method of its treatment has been, in the first instance, some form of *Magic*. But magic in the anthropological sense does not

connote legerdemain or conjuring tricks. It belongs rather to the realm of primitive religion. To it may appertain a wide variety of occult powers which only come into operation when more precise knowledge and experience do not suffice. Its elements include hope and baffled desire, imitation, spiritual afflatus, or the particular belief entertained as to causation. The Magic or its agency may be valid or not valid, but it is usually a rational sequence derived from the idea of aetiology. Its practice may have originated in Babylonia or Egypt, and been widely diffused therefrom, or it may have arisen independently as a response of the human spirit to meet diverse crises. In any case its practice appears to be universally distributed in the human family. In this University Dr. Singer has told us how the magical practice of early England has come down to us in manuscripts and folk-lore, from the Greek through the Latin, through ecclesiastical and Salernitan texts, through Byzantine theurgy and Roman spell, through Teutonic herb-lore and Celtic magic, the doctrine of specific venoms, the nines, the worm, and the elf-shot.

Let us now consider some of the forms of its application. As the explanation or assumed justification is obscure and nebulous, so also are many of the applications. In recent years they have been more fully investigated, but much of the true inwardness will probably never be known, for we are passing from the stage of intuition and mystery to the hard facts of natural causation, verified by experimentation. In the *Natural History* of the Elder Pliny are recorded numerous and varied superstitions of mankind as to the natural origins of medicine. From Babylonian and Assyrian sources there have come to us belief in demonology (demons either as aggressive or defensive) and its application to the treatment of disease. With demonology and demoniac fetish there was associated witchcraft, meteorology, and astrology, the supposed therapeutic effect of the sun, moon, and stars, the mystery of days and dates, concurrent with various forms of domestic treatment and prevention. Flight was the sovereign remedy, and although there was total ignorance of contagion and infection, common sense suggested

the discretion of escape. Herodotus refers to many instances of the prevalence of these beliefs, and to manifold forms of domestic therapeutics and prophylactics in the ancient world, such as blood-letting, vapour-baths, massage, heat and cold, poulticing, counter-irritation, some of which had been acquired from the imitation of animals.

Rivers differentiated the practice of healing and prevention among primitive races in two categories. There were forms of healing which came within 'man's own powers', methods of specific magic; and there were forms which were looked upon as the exercise of 'some power in the universe greater than man', methods of divine healing. Methods of specific magic almost always find expression or application in concrete form. The spirit of magic and its potential energy is, so to speak, embodied, or implemented, in practices derived from natural sources, from the animal, vegetable, and mineral world. Sometimes they are used by the individual or the community as a result of experience; sometimes their application is discharged by the magician, the native doctor, or the medicine man.

Animal Origins and the Serpent

Animal life provided man's nearest neighbours and furnished a part of his food-supply. Animals were also his most immediate enemies. In effect, animals and their habits were the commonest object of his study and imitation. From them he learned, *inter alia*, the beginnings of treatment and even prevention. He observed that they had three principal occasions for retirement or concealment—the first for rest and repose; the second in time of sickness, ill health, or wounds; the third at the period of parturition. There was indeed a fourth occasion adopted by certain animals in long-period hibernation. As man pondered on these habits he began to realize their value, and their adoption found a natural response in his own animal nature. He also came to inquire both as to the means and occasion of such retirements and their respective worth in result.

Aristotle and Pliny have furnished us with the current interpretation of their times. They knew that secretiveness

dominated every stage of parturition in animals, that they assumed appropriate and effective posture for the easier natural delivery of their offspring, that they conducted their own simple acts of midwifery, including the severance of the cord, that many of them concealed as others consumed the placenta and secundines, that they secured the maintenance of the body heat and cleanliness of the foetus, and that they used herbal or other means for controlling both post-partum haemorrhage and lactation. Such points became the subject of the vigilant observation of primitive man, as in later ages of scientific inquiry.

In practice these habits of animals were imitated with such human modifications as suggested themselves to primitive woman, and so in different tribes or races the care and custom in pregnancy and parturition was slowly evolved. Some women were delivered standing, some in a sitting posture, and others recumbent, each attitude being still adopted in different parts of the world in our own day. No doubt in the gradual development of custom in this matter instinct, curiosity, and convenience played a concurrent part with imitation. Why is the placenta consumed, they asked themselves, by certain animals, such as deer, zebras, marmosets, rabbits, sheep, sows, cats, and some wild cattle? Chinese medicine believed it had aphrodisiac effect; some of our own early pharmacopoeias recommended its use as a galactagogue, an aphrodisiac, and a laxative.

The instinctive practices of animals and their relation to human custom are, however, much wider than can be illustrated by any single example. Man's observation of animal behaviour included recognition of many direct forms of treatment in sickness. The dog would lick his wounds, as Shakespeare said,

> 'gainst venom'd sores the only sovereign remedy,

would extract thorns, would eat certain grasses for their emetic and purgative effect. Other animals for purgative purpose have the faculty of selection of herbs, gained by instinct or experience. Sick animals may prefer to lie in the sun or shade; they rest a broken limb, and as Darwin

noticed use one or more limbs to save movement in the affected limb. In certain diseases they avoid light and noise. The sound condition of their teeth and digestion is due to the consumption of constructive and detergent foods. Various animals, including the hippopotamus, the vampire bat, and the leech, possess the power of relieving themselves of a surfeit of blood, and have at one time or another been credited with having taught mankind the value and means of blood-letting. Pliny held that it was from the swallow that man learned the use of celandine for disease of the eye, and hawk-weed, fennel, and euphrasia have been similarly used. To the skins of animals was attributed healing value in the Ebers papyrus, and it will be remembered that Sir Walter Scott was, as an infant, wrapped in sheep-skin. 'Blood cures' were advocated under the Mosaic Law, the blood of goat, sheep, cat, ox, and cow being used for therapeutic purposes; and ants and the cobweb of spiders used as styptics, and herbs as antidote for snake bite, derive from ancient custom.

Much the most remarkable of all the animals associated with the healing art is the *serpent*. It is the most common, universal, and ancient of all the emblems of Medicine. Asclepius, son of Apollo and Coronis, was taken from his mother's body and given to Cheiron the Centaur to be taught the use of herbs, serpent-lore, and the cure of disease from Nature, on the slopes of Mount Pelion. He became the special god of healing, and acquired the power of raising the dead. This faculty so greatly disturbed Pluto that he complained to Zeus, who destroyed Asclepius with a thunderbolt. He left behind him two sons (Machaon and Podaleiros) and four daughters, Hygieia, Panacea, Egrea (who, marrying a serpent, was changed into a willow tree), and Jaso. One of these daughters was said by tradition to have given birth to Hippocrates. Now Asclepius, in figure of a man, is almost always represented with a serpent twined round a staff. One alleged reason for this emblem was that when Asclepius attended Glaucus a serpent brought him a herb for the cure of his patient, and twined itself round his staff. Thus the serpent became a sign of the Asclepiad

family (Hygieia being represented usually as feeding a serpent from a saucer) and the hall-mark of Asclepiad temples.

But the serpent was also adopted as the imprimatur of other gods of healing in India, Egypt, Greece, Phoenicia, Babylonia, Arabia, Crete (3000–2000 B.C.) and elsewhere. The Vedas were believed to have been lost in the deluge and recovered by a serpent. In course of time the serpent was accepted as the promise of healing, and Moses raised it in the wilderness in time of pestilence (1400 B.C.) that all might see it and be saved. It became an object of worship and a healing agency; it was adopted also as a totem, a charm, and the ancestral deity of tribes. Even to-day it is used throughout the world, in civilized and uncivilized races alike, as an amulet (not to be purchased, but given or found) in brooches, bracelets, rings, necklaces, belts, and girdles.

It is impossible to determine, historically or scientifically, the grounds for the adoption of the serpent as the representation of the art of healing. Cicero said the ancients laid great store by the fact that the serpent periodically sloughed its old skin and replaced it with a fresh one, and thus expressed recovery and a new life. Its physical characters and powers made an irresistible appeal. As Owen said, it could 'outclimb the monkey, outswim the fish, outleap the zebra, outwrestle the athlete, and crush the tiger'. To primitive man it was the embodiment of animal skill, more subtle than any beast, quick in sight and swift in movement, long lived, sustained on little, virulently poisonous, unique. Moreover, to it were attributed mystical and supernatural powers, wisdom and the faculty of learning, cunning, knowledge of the properties of herbs and of the tree of life, of the voices of birds, the language of plants, and the future. Its apocryphal message, 'thou shalt not die', was invigorating and hopeful. Lastly, it seemed to possess both the causation of disease by poisoning and the power of its healing; living it could apparently produce immunity, dead and chopped up it became an antidote and provided medical skill to those consuming it. What living thing could be

designed more fully to represent the mystery and mastery of Medicine? Beyond this there has been, for thousands of years, the implicit belief, the magic faith, the confidence of mankind in its healing power. The universality of this credulity was its victory. In temples all through the ancient world the serpent was devoutly worshipped, and to it were brought the sick and dying having faith in its powers. As the centuries passed ritual and mythology wove about its head a halo which none could doubt or dare to destroy, and it became a deity.

Though more prosaic and less dramatic, the *vegetable kingdom* also yielded abundant resources to the early seeker after healing by specific magic. The golden bough (mistletoe) and trees and herbs find their place in the Ebers papyrus, and the Rig Veda mentions some hundreds of healing herbs. The pine, arbutus, elder, and upas trees are as ancient in folk-lore as the Babylonian mandrake. The poppy, penny-royal, St. John's wort; the madonna lily and belladonna; henbane, hemlock, valerian; primrose, sage, thyme, dandelion, and marjoram—names so familiar to us—have for long ages been the accredited simples of the magician-herbalist. Diocles in the fourth century B.C. designed the first herbal, and the great herbalists of the fifteenth and sixteenth centuries are his descendants. Tomlinson (1657) cites 36 examples of drugs of animal origin and 280 of vegetable, and Dr. Dan Mackenzie has drawn up a list of 150 modern pharmacopoeial remedies dating from early folk-lore.

Mineral remedies and charms have been used in all primitive races, such as chalcedony, topaz, coral, loadstone, amber, serpent stones, cowrie shells, flints, and various metals. At initiation ceremonies among the Kikuyu the ear-lobes were expanded to hold metal or wood ornaments, and cowrie straps and cowrie waist-fringes were worn, with monkey tail attached to the elbow, cat skin, bracelets, and anklets. Further, special 'holy' springs are found all over the ancient world in addition to sacred rivers (Jordan, Nile, Ganges, &c.).

The Medicine-Man

As the priest was the ordained exponent of divine healing, so the *medicine-man* was the interpreter of therapeutic magic. But he was something greater and more awesome than priest or magician-herbalist. He may have belonged by descent to a medical family or he may have been 'called' or initiated by the wise men of his tribe or totem, but in any case he was the typical leader of primitive society and his was a function never absent from the social organization of the group. He could exercise his magic through the use of tangible things, such as blood, hair, teeth, saliva, leaves, skins of birds and reptiles, &c., or in intangible things such as rays of light, shadows, echoes, noises. He could even discharge his professional duty by means of incantations, words, names and numbers, or particular spells. He was attired with imposing and often awe-inspiring dress, consisting of many totems, emblems, teeth, bones, beads, and trappings indicative of witchcraft or former cures. He carried in his 'medicine bag' his tangible things, or parts of dead animals, totems, grass, moss, leaves, shells, stones, with which, as in the Solomon Islands, he would rub the patient. His operations were usually confined (*a*) to the exorcism of the evil spirit by terrifying it with impressive dress or rattles, drum-beating or shrieking, (*b*) to sucking out poison or its removal by a ray of light, (*c*) to herb-doctoring and the provision of domestic remedies, and (*d*) to presenting to the patient some form of prophylactic fetish.

Among the Kikuyu in Kenya every class formerly had its own medicine-man. He was born, 'called', or trained to his avocations, which were four in number. He was able to purify from ceremonial defilement (some thirty forms of infringement of taboo or custom); he had the power of divination; he made charms which could bring evil or protect against it; and he practised as a medical man. His medicine bag contained various magic oddments, and his pharmacopoeia consisted of a score of drugs of animal or vegetable origin for prevailing diseases. The Kikuyu native

MEDICINE MAN OF AMERICAN INDIANS

By courtesy of MESSRS. LIPPINCOTT

MEDICINE MAN OF AMERICAN INDIANS

also received a medicine bag for himself worn as a satchel, or as part of a necklace or an anklet. Among the Winnebagoe Indians of North America medicine-men were numerous (in 1848), each with his secret universal panacea. Blood-letting, hot and cold baths, cupping, and animal and vegetable drugs were used. The medicine-men of the Dacotas used scarification, incantations and spells, blood-letting and blood-sucking, steaming, and secret vegetable drugs.

The medicine-man or witch doctor still exists, of course, in many parts of the world and is likely to thrive so long as witchcraft survives. We must remember that the practical disappearance of witchcraft in England and other civilized states is of recent date. It was prevalent in the England of Shakespeare and has lingered much later. To-day it is a shadow across Africa and some other countries, inculcating and breeding fear, superstition, and savage custom. In such regions of the earth the witch-doctor remains part of a system co-extensive with native life and tradition.

Primitive Religion and Medicine

I turn to say a few words on the exercise of what Rivers called 'some power in the universe greater than that of man' in relation to primitive treatment and prevention of disease. When man is faced with the unknown and the inscrutable, or with some overwhelming yet unfulfilled desire, he bethinks himself of his gods. This is not because particular men or tribes are more religious than others, but because, as Malinowski has pointed out, 'religion fulfils at vital crises an indispensable function in the scheme of human culture'. It is an integral part of the custom, magic, and social organization of primitive man. Indeed, as Marett says, 'magic and religion belong to the same department of human experience. . . . The religion of a savage is a part of his custom; nay, rather, it is his whole custom so far as it appears sacred, so far as it coerces him by way of his imagination'.

Emotion, too, played a great part. It has been said that 'knowledge is power, but emotion is the master of our

values, and therefore of the uses to which we put our power'. The body is not a 'prison house' of the human spirit, but its outward tabernacle, its vehicle and embodiment. The mind and body are not in conflict, the immaterial versus the material: together they are one inseparable unity of personality, a single embodied self. The fundamental aim of primitive religion was to safeguard this life. Magic was the exercise of human occultism, of unseen powers, by various means, medicines, rites, and processes; religion depended upon some higher power. Magic often led up to it, it possessed a strange potentiality of religion. As Dr. Oman says:

'The significance of magic will be evident if we realize that its use is for peoples whose ideas and feelings are fixed in special contexts, and are in particular inseparable from the context of mass-impression. What magic ritual does is to stage the situation according to the desired result, with the traditional sacred setting in which the higher emotions are fixed, and with the solemn assembly to be, as it were, a sounding-board for it. Minds lacking free ideas cannot escape situations, but they can fashion the situation to give the effective fixed context.'

An unprogressive people would be satisfied with such an imitative or pseudo-victory, and stagnate in it, stereotyped in their magical institution. For long periods of time and in certain races this has remained the position, but for progressive minds freedom of staging and growth in ideas would emerge. As Dr. Oman adds:

'Magic, it is true, would then cease to work because its efficacy depends on minds which have their ideas fixed in accustomed contexts, and are imperfectly shielded from the passage through them of crowd-emotion. But it is by this possibility of progress and not by what remains as the mere terror of neglecting any possible security, that the significance of magic should be judged. Irrational as magic may seem to us, and it is in a sense both pre-rational and pre-mechanical, yet with it man had his foot on the ladder by which he rose to reasoning about his environment and to managing it. . . . Magic, however, like all else in man's development, should be judged by its use not its abuse. At its creative stage it is religion, because its effective setting is sacred tradition, its feeling is at least akin to

the sense of the holy, and its power is of the nature of the Supernatural. . . . Magic might be described as mysticism in the fetters of fixed idea.'

Thus the sanction of the Supernatural, however beclouded by magic, makes man's conduct in some sense moral, something standing above the mere ebb and flow of impulse or circumstance, an estimate of himself, body and all, and 'all in all', his fellows and his ultimate environment which cannot be measured by material advantage only. In a word, as Frazer has expressed it, 'the history of religion is a long attempt to reconcile old custom with new reason'.

In the civilizations of the ancient world the healing of disease, and its avoidance or reduction, by means of divine intervention, were ultimately man's predominant hope. As we have seen, he believed that disease originated in the subnatural, the human, or the supernatural, and nothing could control it in the long run but some power in the universe greater than himself. Such power was exercisable in two ways, there was direct intervention of the healing gods by their very presence or touch, or there was indirect intervention by the priests or those whom the gods ordained. Such indirect intervention in primitive society was performed by priestcraft or witchcraft. Not every primitive society possessed a priest, though the medicine-man and witchcraft were practically universal. But the growth of civilization brought with it an organization of institutional religion, at first simple but in due course elaborate.

The earliest Egyptian papyri give a place to religious incantations, and Babylonian, Hindoo, Egyptian, and Mosaic records indicate that appeal was made by the sick to the temples of the gods for divine healing by (*a*) employment of oracles, (*b*) incubated sleep, dreams, or visions, (*c*) the use of spells, omens, or incantations, (*d*) the touch or lick of sacred animals, and (*e*) the priestly application of herbs, waters, or massage. In these means men have placed their confidence at all times, believing them to be instrumental—through magic, through ancestral spirit, through exorcism or transference, through 'burnt-offering', or through faith—in the removal or cure of disease. All these various

means represent a theurgic, theosophical, or 'hyper-physical system' lying wholly outside and beyond the conception of the natural law of cause and effect. They have dominated the minds of men from the remotest times to the present day.

As in primitive and savage races, so in the ancient civilizations, the highest conception found expression in a belief in a supreme divine being of definitely ethical attributes; subordinate, anthropomorphic, and ancestor spirits came next; and the lowest forms of supernatural beings were occult nameless powers of good or ill luck.

No better example of the prevalence of healing gods can be found than that obtaining in Egypt. Ra, the sun god, was believed to be the founder of State religion as early as 2750 B.C. He was the universal deity associated directly with healing; Osiris was the god of the Nile and of immortality, and his sister Isis, goddess of vegetation and fertility. She was the popular divinity of health and domesticity, caring in particular for women and children. Horus was the offspring of Osiris and Isis, and by the latter was taught magic and its application to the healing of disease. He was the god of the day, the most beloved of the Egyptian gods of healing. Ptah was the god of wisdom, the creator of gods and men and famous for his therapeutic power. Last may be mentioned Thoth, the moon god, the creator of knowledge and science, including medicine, whose temple was at Philae. All these gods had Temples of Healing and oracles, the temples containing votive offerings recording cures, and sometimes medical libraries of papyri. Attached to the temples were priests, physicians, and magicians, the last named predominating. The methods of healing were incantations, religious rites, the 'incubation' of sleep and dreams in which the god revealed his remedy, and in many temples various direct forms of treatment.

In Greece these temples of healing served a wider preventive purpose. They were dedicated to Asclepius, the god of medicine, of whom I have spoken. They were distributed throughout Greece in salubrious situations (chosen according to tradition by serpents) and existed

elsewhere in Europe. In some centres they became celebrated, Cos, Cnidus, Epidauros, Mitylene, Athens, and Pergamos, and prevailed for a thousand years, being supported in whole or part by the State. The hieron or enclosure, constituting the asclepeion, usually contained the central temple of Asclepius, which contained a figure of the god with a golden serpent and a temple dog; the abaton or hospital ward had an open colonnade on the south side, for admission of fresh air and sunlight; the tholus was a circular building, Doric without and Corinthian within, containing a sacred well and being the home of the sacred serpents; a temple of Artemis, and other temples of healing divinities; a gymnasium; an auditorium for the presentation of Greek drama; hostels. These temples were not used for ordinary worship. They were more of the nature of open-air sanatoria in the hands of the Priests of Asclepius, who used a few simples promoting elimination, temple sleep, or 'incubation' facilitating elementary psycho-therapy, and advice and practice in dietary, cleanliness, healthy living, and recreation. It was customary for a patient, after his treatment, to present to the temple a votive offering, often with an inscription of his ailment, and in this way the temples accumulated both therapeutic and clinical records. Mr. Walter Pater considered the whole institution as mainly preventive in purpose.

Conclusion

Finally, we shall naturally ask ourselves what the enduring contribution of folk-lore and magic has been to Preventive Medicine. At first sight, and in view of the scientific progress of the last four or five centuries, it may well appear that relatively little remains of its influence. Was it then merely a passing phase of primitive and even savage custom and witchcraft which had no continuing or constructive effect?

No one, I think, can consider the evidence to which reference has been made in this lecture without recognizing that folk-lore and magic formed the beginning of a science and art of Medicine. For in the first place, they were the

original expression of the primal instincts of hunger, of sex, of fear, and of the security and preservation of life. Little though we can apprehend the inner meaning that such expressions possessed, we do know that for thousands of years folk-lore, magic, and totems, and the customs and customary law which arose out of them, constituted not a disruptive or disintegrating factor in human society but an organizing compulsion which created tribal unity, and which favoured the growth and expansion of the human spirit. Moreover, the formulation of its ideals and the discipline which their practice involved led to the social organization of a local, tribal, or racial community, giving it both a tradition and a practice, which provided a basis for its solidarity and for its physical survival as an economic unit and functional expression of human society.

Thus folk-lore and magic initiated a functional service in primitive form, which among its other enduring values both cemented social structure and gave it a dynamic influence. No doubt it was pragmatic, and irrational in the modern sense. But it exerted a dominant effect, much of which still remains.

When we come from the wider social evolution thus initiated to the specific medical results which remain to us, we shall find these also to be substantial. Anthropology itself may be the child of Darwinism, but it has found in folk-lore and magic its elemental data. Many of those data represent principles which remain as part of the structure of modern medicine, particularly in its preventive and conservative aspects. The preservation of human life in the early ages of man's existence on the earth was dependent upon factors and conditions which still continue to govern the situation. The food quest, the sex function, and the problem of the number of population are now, as then, the primary issues, and the health governance of communities still continues to be a vital function of statecraft. Even in the forms of medical treatment and prevention of disease much that we now practise throughout the civilized world derives from far-off folk-lore, and has its origin and potential energy in the magic and religion of the earliest times.

Nor must we allow ourselves to think too lightly or sceptically of folk-lore, magic, and custom as an expression of natural religion. It is obvious that the outward forms of the religious instinct, so full of mystery for us all, have changed in the course of the ages, but that instinct or impulse, call it what we may, modified by the emergence of varied Faiths, remains in the human mind as the greatest single governing factor in the conduct of men. The student and observer of the origin and progress of the art of Preventive Medicine cannot fail to recognize that fear, lust, cruelty, and avarice are still with us, but so also are the higher faculties of humanitarianism, charity, faith, and hope, and the higher ideals of goodness, truth, and beauty; and all of them have a share in the springs of human action and in the fundamental ends of human aspiration. It is no part of the scientific method to overlook or ignore this fact. For religion is a growth out of the whole nature of man.

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II

EGYPT AND THE MOSAIC LAW

Synopsis of Lecture II

Egypt, the focal centre of various civilizations, which cross-fertilize each other, e.g. Minoan, Syrian, Assyrian, Babylonian, Ethiopian, Indian, Persian, Greek, Roman.

The Pyramids, Hammurabi Code, the Vedas, Assur-bani-pal.

Egyptian Medicine itself a palimpsest of medical learning, demonological and scientific.

(*a*) The healing deities, Ra, Osiris and Isis, Horus, Ptah, Thoth, Imhotep. Various groups of deities:
  (i) of the underworld, inflicting disease;
  (ii) of ancestors, families, localities, heroes, tribes;
  (iii) of animals incarnated or deified;
  (iv) of signs of the cosmos (sun, moon, Nile).

(*b*) Pyramid texts and medical papyri.

(*c*) Twenty-six Dynasties during 3,000 years B.C.

(*d*) Mummification.

(*e*) Temples, rites, libraries, votives, priests, physicians.

Practice of Preventive Medicine in the land of Egypt. The evidence of Herodotus.

The Mosaic Law. The Pentateuch and the Talmud.
Defilements and purifications, leprosy, cleanliness of body, the 'plagues' of Egypt, laws of sexual relationship, childbirth, circumcision, protection of water and food, sanitation, the Sabbath Day.
'*More than any other factor, the day of rest gave them strength to assert themselves among other races.*'—Sudhoff.

II

EGYPT AND THE MOSAIC LAW

When we begin to think about the historical and scientific facts concerning the rise of the principles of Preventive Medicine our minds turn naturally enough, in the first place, to the land of Egypt. For whilst Mesopotamia has for long been looked upon as the nursery, if not the actual cradle, of the human family, and whilst the Minoan civilization may prove to be the origin of its culture, it is in Egypt that we find the focal centre of light from elsewhere. It is there that the early civilizations, intermixed by migration, cross-fertilized each other. It is there we find folk-lore, magic, and religion being assimilated with, if not partly the origin of, oriental civilization.

When we glance at a map of the ancient world we shall see some of the reasons for this unique position of Egypt. It lies at the end of the Mediterranean basin, at the south-east corner of the circuit of lands which lay on the shores of the middle sea—Carthage, Rome, Greece, Syria—with Babylonia and Assyria on its eastern and the Libyan desert on its western coasts. The civilizations which grew up in Mediterranean lands owed their greatness to conformity with Mediterranean conditions. The Empires of Minos, Athens, and Rome are successive attempts to realize a civilized *orbis terrarum* on particular geographical conditions. The social evolution of human institutions took place on the shores of this ancient sea, coming partly from islands within its ambit and partly from the Far East. And in the course of centuries, pressed by the genius of Caesar, it was to spread westwards over Europe and ultimately across the Atlantic. The map shows that this ancient world not only possessed its midland sea as the universal waterway common to the group of lands, but it had also its great river valleys and its 'land bridges' particular to each. The Euphrates and the Tigris were to Babylonia what the Nile was to Egypt, the essential physical agent of their civilization, around which their populations both gathered and

intercommunicated. The broad bare land on the western bank of the Euphrates and the narrow strip bordering the Mediterranean and separating it from the Arabian desert was the great land bridge, 'by the way of the sea', which made intercourse possible between Babylonia and Egypt. Along this dusty track passed the peoples, the commodities, and the ideas which began Western civilization; and along it went armies as well as caravans. A glance at the map thus shows that Egypt was central, and a link between the civilizations before Greece and Rome.

But these were externals. The internal conditions of Egypt had still greater influence upon its history. Egypt is the Nile, and the Nile is Egypt. It is the Nile which makes it long and narrow, which brings it a rich, alluvial, and irrigable soil, which for a hundred days every year waters its land, which linked it with the limestone of the Libyan desert and the Nubian frontier, and furnished it with a means of intercourse within itself. Egypt was thus, from time immemorial, capable of supporting a population out of all proportion to its area, an agricultural population dependent upon organization and mutual co-operation, with immense natural resources and defences, and with a favourable climate. Libyan limestone and Aswan granite afforded it building material, its rich soil gave it luxurious vegetation, and its safeguarding defences a composite people persistent against nomadic invaders. Thus it became a favoured land and a selected people, skilled in agriculture, in building, and in arts and crafts, among which pottery was the earliest. Their settlements were large villages confined to the land above the flood-level of the Nile; their cemeteries were perched on the higher spurs of their settlements; they practised land irrigation; they navigated the Nile in large boats of their own invention; they designed and manufactured utensils for domestic and agricultural purposes; and they provided amply for the necessities of their social, tribal, and religious institutions. Here were collected the objective expressions of the folk-lore, the magic, the demonology, the totemism, and the systems of tribal governance of primitive man. Above all, they sought high

and low, through the ages, for some means, occult or known, of avoiding the inevitable disintegration of death or at least the postponement of its event.

Though in the passage of the centuries much has been lost, and more still has been changed, in the civilizations which have been built in Egypt, we are fortunate, as we shall all remember, in possessing the evidence of its characteristics by a competent eyewitness 500 years before Christ. In the history of Herodotus, the famous traveller in the Greek world, the student of Preventive Medicine will find the most graphic and living account available of the character and the meaning of the early civilizing aspirations of man. 'All the business of all the world is his, and he enjoys it. He rambles, he digresses, he looks as if he might be wasting time—but he never does.' This wonderful historian was born in 484 B.C. in the Hippocratic Age at Halicarnassus, looking out over the Aegean, and he brings all the Ionian birthright of genius, of curiosity, and of forward-looking thought which made the Ionian seer the heritage of Greece. He travelled, and noted what he saw, and the things which he saw are of great importance to us. He was in Egypt between 460–455 B.C. and looked at a civilization which was then at least thirty centuries old. He tells us that Egypt is 'an acquired country, the gift of the river', and that it is a 'tract gained by the inhabitants', who obtain the fruits of the field 'with less trouble than any other people in the world'. He bears witness not only to their natural circumstances but to their social and domestic habits, to their institutions, to their appreciation of history, to the invaders to which they had been subject, to their manners, customs, and religion, and he adds: 'they are, I believe, next to the Libyans, the healthiest people in the world—an effect of their climate, which has no sudden changes. Diseases almost always attack men when they are exposed to a change, and never more than during changes of the weather.' On the views which Herodotus holds regarding hygiene I shall have something to say later on, but it is obvious that here we have one of the earliest historical documents concerning the rise of Preventive Medicine.

Egypt as focal centre

We have not, however, quite finished with the internal conditions of Egypt which immediately concern us. Clearly, its natural conditions were favourable to a developing civilization. But its principal contribution to the solution of our particular problem is the history of what actually happened. Now what happened was this: it passed through a long and amazing period of development, absorbing the learning of other empires, and transmitting its composite experience to after ages; it became a treasury and storehouse of the ancient world; it left behind it a vast body of empirical knowledge in the crafts and sciences; it developed social organization and embodied the customary law of others; and it bequeathed for our instruction the experience of mankind in the art of living. The First Dynasty of the kings of Egypt seems to date back to some 4,000 years before Christ, and when Alexander drove out the Persians and Egypt passed under the Greek rule of the Ptolemies, there had reigned no less than twenty-six dynasties. The legacy of those dynasties was extraordinarily rich in the experience and institutions which arose from the dominant thoughts of men as to the means of human survival—the pyramids, the pyramid texts and various medical papyri, the sun-temples, the art of mummification, the 'Book of the Dead', innumerable records of healing deities, the tombs of the kings, the splendours of Thebes and Karnak, a vast body of medical learning, and the Mosaic Law. To some of these remnants, so necessary to the understanding of our quest, I shall have occasion to refer. But before doing so I would remind you that some of the greatest influences, directly or indirectly, dating from the Egyptian period of the rise of Preventive Medicine were not Egyptian in origin. They left their mark on Egypt, and by Egypt they were in part disseminated to Greece and thus to the Western world.

I propose to refer to three of them. First, we must recognize that deeply ingrained in the texture of Egypt was the Minoan civilization.

In the year that Queen Victoria came to the throne a little lad named Heinrich Schliemann was apprenticed to a grocer in a small Mecklenburg village named Furstenberg. He was a clergyman's son and had received the rudiments of a classical education, but owing to the straitened circumstances of his parents his scholastic career was prematurely cut short, and the boy had now to sweep the grocer's shop and sell dried fish and tallow candles across the counter. It was a bitter disappointment to Heinrich, for this young Teuton had felt the call of Hellas and dreamed in his Baltic home of the sunny islands of the Aegean. One day there came to the shop a scholar who spoke Greek, and recited to Heinrich some lines from Homer, which so stimulated the boy that he vowed he would learn Greek. He left home, obtaining employment as an office boy in Amsterdam, and there he spent his evenings studying languages. In 1846 he was sent to Russia on business, and from one step to another he acquired the wealth which allowed him to learn Greek to his heart's content, and to travel. 'At last,' he says, 'Heaven had blessed my mercantile undertakings in a wonderful manner, so that at the end of 1863 I found myself in possession of a fortune such as my ambition had never ventured to aspire to. I therefore retired from business in order to devote myself to the studies which have the greatest fascination for me.'

Thus did the grocer's apprentice from north Germany become archaeologist. He married a Greek lady of Athens, established his home there, and travelled in the Near East. In 1870 Schliemann began his excavations of Troy on the hill of Hissarlik, and unearthed the rich 'treasure of Priam'; four years later he excavated at Mycenae, and in 1886 in Crete. In those early years of excavation the work was empirical and rough and ready, but to Schliemann, the merchant-archaeologist, belongs the enduring credit of pioneering.

Sir Arthur Evans visited Crete in 1894 and began excavation of the palace of Knossus in 1900. His work, and that of Petrie and others, has established that the Early Minoan civilization dates from 3400 to 2100 B.C., that the Middle

Minoan belonged to 2100–1580 B.C., and that the Late Minoan came down to 1100 B.C. The Minoan Age covers the whole of the Bronze Age and part of the Iron Age. It was characterized, at first, by high cultivation of the arts, of pottery, frescoes, architecture, and sculpture; by literature in the Cretan script; by the worship of the snake goddess; by road-making and sanitary engineering, by house construction, by drainage, baths, and lavatories; and by cremation and dwellings for the dead. The order of events is instructive, and passed into the land of Egypt, some of it possibly belonging to a period earlier than the First Dynasty.

A second infiltration came from Babylon and Assyria. It may be described as infiltration because for centuries there was intermittent intercourse by means of the land bridges between Assyria and Egypt, intercourse which became invasion in the time of Esar-haddon (666 B.C.), the father of Assur-bani-pal, whose great library at Nineveh contained 20,000 cuneiform clay tablets, of which between 500 and 1,000 are medical works, containing prescriptions. In Babylon the physician is mentioned as early as 2700 B.C., and the Code of Laws enacted by Hammurabi, king of the First Dynasty of Babylon (*circa* 2000 B.C.), refers to the medical treatment of wounds, of abscess of the eye, of cataract, of fractures, and of disease of the bowel. It was this code of law which fixed the scale of medical fees, imposed penalties for failure to heal, and witnessed to the high degree of organization of the profession. Herodotus reports a custom in Babylon of laying out the sick in the public square so that passers-by who had suffered from the same malady might offer advice. More important to us than these matters, interesting though they may be in the evolution of Medicine, was the advanced state of drainage, sanitation, and hygiene in Assur, Babylon, Nippur, and in the palaces of Tikulti, Sargon, and Nimrod. Indeed, it is conjectured that sanitation on the grand scale was earlier and more elaborate in the great cities of the Euphrates and Tigris than in those on the banks of the Nile. Many of the tablets in the great library at Nineveh, as well as the advanced sanitation in the cities, derived from Ur of the

Chaldees, and from that source or Assyria filtered into Egypt. The similarity between the medical contents of the Assyrian clay tablets and the medical papyri of Egypt suggests a common origin.

There was yet a third influence which penetrated Egyptian Medicine and it came from still farther afield geographically, though later in time, than the Babylonian. This was the ancient Hindu Medicine which dates some 1,500 years before Christ. It was embodied in the immortal Vedas, some of which were composed, according to tradition, by Brahma himself (Rig, Ayur, Sama, and Atharva Vedas). The Ayur Veda dealt in eight sections with: (*a*) the surgery of removal of foreign bodies; (*b*) diseases of the head and neck; (*c*) fevers and diabetes; (*d*) demoniacal diseases; (*e*) medical treatment of children; (*f*) antidotes for poisons; (*g*) medicines to preserve vigour, restore youthfulness, and prevent disease; and (*h*) the use of aphrodisiacs. Mixed with these therapeutic advices there is much of theurgic medicine, magic, and charm; and a good deal of it, therapeutic or incantation, was in advance of the Assyrian, Egyptian, and Greek Medicine contemporary with it. The medical profession was organized, and a system of medical education and apprenticeship in vogue. The leading physicians and herbalists were Atreya (sixth century B.C.); Susruta (fifth century B.C.), the surgeon; Charaka, a physician (second century A.D.); and Vagbhata, the writer. Atreya and Susruta summarized the teaching of the Vedas and endeavoured to free it from priestly dominion and introduce the elements of scientific observation and deduction. This was perhaps the first attempt to draft a system of Medicine. Benares and Taxila were the principal centres of Hindu Medicine, which was disseminated in Egypt, Sicily, and Greece before and after Alexander the Great (327 B.C.) and the Seleucids. Dr. Comrie of Edinburgh says that Hindu Medicine, though it succumbed eventually to the medicine of the West, added to the current knowledge of leprosy and diabetes, contributed to the surgery of rhinoplasty and ophthalmology, and provided many useful drugs. It certainly penetrated Nestorian Medicine at Edessa and

Gondisapor and was absorbed by the Arabians, of whom I shall speak elsewhere.

Before I leave Hindu Medicine a word must be said about its teaching in regard to hygiene and prevention, which, though like the Mosaic Law based in some degree upon religious observance, had a widespread practical value. A thousand years later it constituted a substantial part of Mohammedan practice wherever the faith of Mahomet held. Dr. Comrie has summarized Hindu personal hygiene as follows:

(*a*) Cleanliness. Daily washing and the care of the evacuations were inculcated. The teeth were to be cleaned by a fresh stick broken from a bitter tree; the tongue was rubbed; the mouth rinsed; the eyes anointed; the body, head, and footsoles oiled every day; and the hair, beard, and nails were to be regularly trimmed.

(*b*) Diet. Two meals daily (corresponding to breakfast and supper) only, were to be taken; and there were rules to cover the articles of diet, order of the dishes, &c., as in the celebrated rules for health of the School at Salerno (A.D. 1000); a short walk after meals was recommended. The most important articles of diet were: the cereals, especially rice, fruit, vegetables, nuts, ginger, garlic, salt, water (rain water recommended), milk, oil, butter, honey, sugar-cane; of meats, gamebirds and buffalo were considered healthier than pork, beef, and fish; and it is to be noted that meat and alcohol, though forbidden by religion were not so by medical authors.

(*c*) Exercise alternating with suitable rest, massage, baths, and gymnastics were all held to be of value in preserving health. The daily bath was recommended; but curiously, warm bathing was held to be good only for the lower half of the body, for the upper half it was bad. The wearing of clean clothes was enjoined, while garlands, ornaments, and jewels were supposed to confer extra strength and ward off evil spirits.

(*d*) Elaborate restrictions were placed upon sexual intercourse, which was forbidden on the 8th, 14th, and 15th days of the month, and in the morning.

(*e*) Prophylactic measures were recommended, such as an emetic every week, a laxative every month, and blood-letting twice yearly; these methods of internal cleansing remind one of the practice of the ancient Egyptians, as described by Pliny.

It will be noticed that much emphasis was laid upon cleanliness of the body within and without, a vitamin diet,

and exercise. But, as Dr. Fielding Garrison has pointed out, the range of Preventive Medicine in Indian Medicine far exceeded rules of personal hygiene. It included the knowledge of human inoculation against small-pox, the localization of bubonic plague in rats, an elaborate system of infant welfare, the use of mosquito netting, mosquitoes as carriers of malaria, antidotes and inoculation against snake poison. It is clear that many preventive practices adopted in India and Persia had, at an earlier date, been followed in Egypt. There was, indeed, for centuries abundant 'cross-fertilization' and diffusion of preventive methods in the lands of the ancient world.

We must now turn to the actual contribution of Egypt itself to the first beginnings of organized Preventive Medicine. In Egypt for centuries after the decay of the Empire in the Twentieth Dynasty—Rameses III, 'the last of the great Pharaohs'—Preventive Medicine had little or no scientific basis until Greek Medicine transformed the Alexandrian School in the fourth century B.C. We have already seen that primitive folk-lore and magic covered a universal field of empirical knowledge and experience, and all this entered into the life of ancient Egypt, and because of its favouring circumstances was organized and concentrated there.

I use the word 'organized' as conveying the impression of greater systematization, an increased degree of formulation, and an authorization by the governing authorities. It was still magic, theurgic and wholly without scientific observation or foundation in the modern sense. But in Egypt it began to pass out of the hands of the sorcerer, the witch-doctor, or the medicine-man into the hands of the priest and the lawgiver, out of the hands of the ignorant and unintellectual into the hands of the intelligentsia and the educated.

The first of the trained leaders was Imhotep ('He who cometh in peace'), born at Memphis somewhere about 2900 B.C. in the time of the 'Old Kingdom' of Egypt. He was vizier, architect, chief ritualist, and magician—physician to the great King Zoser. To Professor Kurt Sethe and the late Dr. Jamieson Hurry we are indebted for a biographical account of this remarkable man, 'the first figure of

a physician to stand out clearly from the mists of antiquity', as Osler said. Unfortunately we know nothing of his early history, nor is there any record of his appearance in the flesh. He was evidently a learned and versatile man who devoted his life to various activities. He is first heard of as vizier to Zoser, then as architect, 'the chief of all the works of the King of Upper and Lower Egypt', who probably designed for his royal master the well-known Step Pyramid of Sakkarah near Memphis, and a temple at Edfu (replaced by the present temple constructed in 237 B.C.). Imhotep was also chief lector priest to Zoser, the principal sage and scribe, a species of remembrancer and poet laureate, and probably an astrologer. Although there is no contemporary evidence of Imhotep having been a physician, he was soon after his decease looked upon as a 'medical demi-god' and 2,000 years later (525 B.C.) was recognized as a full 'deity of Medicine' (sometimes under the name Asklepios), and so remained for a millennium. In the interpretation of the Oxyrhynchus papyrus discovered by Grenfell and Hunt, and which was a copy of an earlier one (361 B.C.), they say: 'So far as it goes, the evidence favours the view that the worship of Imhotep (as a demi-god) began in the early days of Egyptian history.' Further, an authentic papyrus records a medical feat of magic performed by the chief ritualist of Zoser. We may therefore assume that in the opinion of his contemporaries Imhotep was a magician experienced and adept in the application of magic and incubation in the healing art, and it was in that capacity that he was deified. Statues and figures of him have been found as 'he who giveth life to all men', holding the sign of life-giving powers, the *ankh* and the *Uas* sceptre, sometimes accompanied by a serpent. Temples and shrines were built in his honour, at Memphis, at Philae, and at Deir-el-Bahari. Festivals were also instituted in behalf of his worship as a god of healing.

Pyramid Texts and Medical Papyri

Whilst as a magician-physician and as a deity Imhotep stands out as a witness of the growth of, and reverence for, the art of Medicine in the ancient world, he is not

unsupported. Pyramid texts and medical papyri provide substantial and indisputable evidence in the same behalf, and in this sphere the work of excavators, investigators, and translators, in recent times, has added greatly to our knowledge.

The earliest medical papyrus which has thus far come to light is that found by Sir Flinders Petrie at Kahun in 1889, belonging to the period of the Twelfth and Thirteenth Dynasties (1850 B.C.). It consists of thirty-five sections containing directions for treatment in gynaecology. There is also a section dealing with pregnancy and sex determination.

The Edwin Smith papyrus (*c.* 1600 B.C.) was found with the Ebers papyrus at Thebes in 1862, and is a record of practical treatment of wounds, forty-eight in number, of the head, neck, thorax, spine, and limbs, with a discussion seriatim of the examination of each condition, with notes on diagnosis, opinion, and treatment, including extracts from magical books. The opinion or 'verdict' appears to have taken one of three degrees: 'It is an ailment I will treat', or 'it is an ailment I will contend with', or, lastly, 'an untreatable ailment'. As Mr. Warren Dawson remarks, 'the magician claimed omnipotence; the physician knew the limits of his powers'. The papyrus suggests that dissection of the human body had been practised, and used as a basis of surgery. Professor Breasted claims that there is evidence that this surgical fragment was written in the time of the old kingdom, before 2500 B.C., and 'probably circulated as a book on surgery when the Great Pyramid of Gizeh was being built'. The passage on the heart, which is one of the significant contents quoted in the Ebers papyrus, finds a place also in this earlier document, possibly indeed its original source. Professor Breasted believes this to be the first evidence yet obtained of the earliest Egyptian surgery and anatomy.

The longest and most famous of the Egyptian medical papyri is that found by Ebers in 1862 in a tomb at Thebes. It is believed to belong to a period about 1500 B.C., but bears internal evidence that some of its contents date from the

First Dynasty (4000–3000 B.C.). Such an exact view must, however, be regarded as conjectural only, as it appears to have been a not unusual practice to antedate origins to enhance their value or authority. In any case its contents were probably older by some centuries than its recorded date. They consist of medical notes from many different sources dealing with diagnosis and symptoms of disease, and record a large number of prescriptions, spells, and incantations for maladies of the stomach and bowels, intestinal worms, diseases of the eye, lungs, liver, head, scalp, mouth, teeth, and tongue, and also for fevers. The original roll contains 110 columns of text.

The most interesting and suggestive words of the Ebers papyrus hint at the earliest knowledge of physiology. 'The beginning of the science of the physician: to know the movement of the heart and to know the heart. There are vessels attached to it for every member.' As Mr. Warren Dawson has pointed out, this is an obscure passage and an extract from an earlier record. Its meaning is not elucidated by the explanation offered in the papyrus itself. 'As to this: if any physician, any priest or any magician place his hands or his fingers upon the head, upon the occiput, upon the hands, or upon the site of the heart, upon the arms, upon the legs, he will make examination for the heart on account of its vessels for every member.' In a word, the writer knew of the heart-beat and its peripheral pulse, but nothing more. There was, of course, no appreciation of the circulation of the blood or the relation of the blood to respired air or to secretions or excretions, although the papyrus itself establishes the fact that at this early period the elements of anatomy and even physiology were being thought of and explored. Above all, the belief was held that the heart was the central organ of bodily existence and the seat of life and spirit.

The Berlin Papyrus 3027 (*c.* 1500 B.C.) contains incantations and prescriptions for the protection of mother and child. The London and the Berlin, 3038, found in a tomb at Sakkarah, consist of a similar mixture of magic and medicine.

Now what do these medical papyri really give us? In the

first place we must not overlook their deficiencies. They are fragments only, remnants of a literature ancient and widespread, beginning as far as evidence shows some 2,000 years before Christ, and not less than a thousand years before any organized Medicine, though they contain knowledge dating probably to 4000 years before Christ. They are incomplete, often removed from their context, and, to a greater or less degree, corrupted by interpolations and insecure explanations. They are intermixed with magic, demonology, and incantation, and heavily weighted with empiricism and superstition. The 'Book of the Dead' was an incongruous collection of magical charms and formulae, fantastic spells against imaginary dangers, which might befall man after death. The Pyramid Texts, which are the funerary records on the walls of the tombs of the kings of the Fifth and Sixth Dynasties, contain lists of the organs of the body with the names of the divinities which protect them, 'there is no part of the body without its god'.

Yet they do in fact give us some quite indisputable evidence, often confirmatory of other knowledge then held. They denote that an art of Medicine was in process of formulation and accepted by the highest existing authority, and receiving educated approval and imperial mandate. Clearly, medical knowledge was held of such importance as to ensure written record. We may go further, it was the beginning of knowledge of diagnosis and treatment. From the mummies and skeletons in Egypt, and from the descriptions contained in these papyri, we know that certain forms of disease were recognized, such as stone in the kidney, urinary bladder, and gall-bladder; arteriosclerosis; bone disease of limbs, joints, and spinal column; tumours and ulceration of bone; talipes; osteoarthritis; gouty concretions; certain forms of rhinitis; mastoid disease; dental decay; and dislocations and fractures. Evidently also there were many diseases of the 'soft' parts of the body, including the skin, the eye, the stomach and intestines (including worms, bilharzia, haemorrhoids), and the male and female generative organs. It has been estimated that not less than 250 diseases were thus differentiated in Egypt. Diagnosis

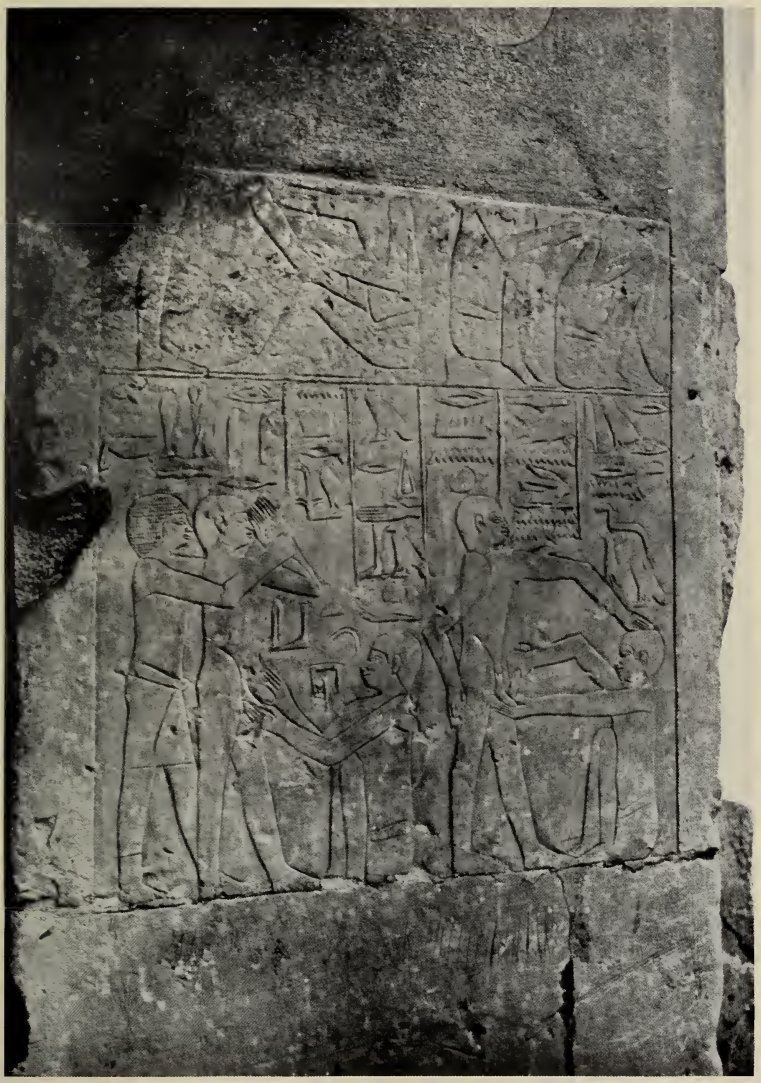
was supported by inspection, palpation, autopsy, and possibly even auscultation. We also know that there was a vast body of therapeutic and surgical treatment, confirmed by the discovery of its means in surgical instruments and medical appliances. The operation of circumcision is depicted on the Sakkarah pyramid (3000–4000 B.C.).

It is clear that surgery was highly developed by the time of the Ptolemies, for surgical instruments are figured on the walls of the temple at Kom-Ombus, and many have been actually discovered—knives, probes, specula, retractors, forceps, cupping vessels, and scalpels. Lastly, the first elements of anatomy and physiology, of osteology and botany, were being sought for. This knowledge was not, of course, all Egyptian in source, but in Egypt it was current knowledge. Such knowledge, and thus derived, was studied by Galen, Dioscorides, and other Greek physicians, and it formed a substantial part of the libraries established at many temples, such as those at Edfu, and in the medical schools of Memphis, Thebes, Heliopolis, Sais, and Alexandria, the contents of which entered into herbals and religious and legal treatises, and came down to the period of the Ptolemies and the Caesars—both for the education of the medical student and the daily guidance of the practitioner.

There is another characteristic of the mentality of the people of ancient Egypt in regard to Preventive Medicine, which found its expression in *mummification* of the dead. Its object was the prevention of the dissolution of the body and the preservation of the form and personal identity of the dead. In their earliest settlements the occupiers of Egypt had buried their dead in dry sand, and had established their cemeteries on the higher spurs of their flat land with the object of escaping inundation and thus the destruction of the body. They had also sought to ensure the continued life of their more illustrious dead by burying them in tombs large enough to contain equipment, utensils, and food for their sustenance after death. The mummification of the dead body by embalming was a method devised to the same end. The earliest instance of such mummification of a dead body of which we have evidence belongs to the period of

CIRCUMCISION, SAKKARAH PYRAMID
By courtesy of FERDINAND ENKE

CIRCUMSCRIBING SQUARE PYRAMIDS



CIRCUMCISION, SAKKARAH PYRAMID

the Second Dynasty, but investigation has demonstrated the wide extent of the practice for the dead of the upper classes, a practice which had profound indirect results.

The process of mummification varied in minor degree in the long history of Egypt, but its fundamentals can be stated in brief. First, there was the extraction of the brain through the nostril; then followed the removal of the viscera, except the heart, cleansing the emptied cavities, which were then filled with myrrh, cassia, or other preservative, sewn up, and the whole cadaver soaked in natron for seventy days; as the head was not immersed it was preserved by a thick resin; subsequently the body was dried, dressed with resin, salt, and fat, and appropriately swathed and bandaged with linen before being coffined. The viscera were wrapped in parcels and placed in Canopic jars, or marked with their tutelary deity and returned to the body. The method of embalming was sometimes abbreviated to evisceration and desiccation.

Although the custom of mummification had a religious purpose and was carried out by priests, it exerted a direct and indirect influence on the growth of medical science. It established a custom of post-mortem examination and gave to those who carried it out a knowledge of the appearance, character, and mutual relationship of the principal organs of the body, and thus familiarized the popular mind for 2,000 years with the idea of dissection. 'Egypt made it possible,' writes Professor Eliot Smith, 'for the Greek physicians of the Ptolemaic age to begin, for the first time, the systematic dissection of the human body, which popular prejudice forbade in all other parts of the world.' It was also the most practical of all introductions to the prevention of putrefaction, and to the study of human anatomy and its comparison with the morphology of animals.

The Preventive Medicine of the Egyptians

Here, then, we have in brief compass illustrations of the outstanding facts regarding the Medicine possessed by the Egyptians. It is a dim and rather obscured picture, a palimpsest composed of different layers of experience, covering twenty or thirty centuries, some of it native-born,

but much of it coming from elsewhere. Even of the medical knowledge of Imhotep, the papyri, and mummification—and the practices of magic to which reference is made in the first lecture—we cannot now say what was Egyptian and what was alien in origin. All we know is that in Egypt it was focused, concentrated, and practised. Though not itself professed as a formulated science or art of Preventive Medicine, it laid the practical basis of prevention.

When we turn to the actual practice of Preventive Medicine in Egypt we are, however, on firmer ground. There are two bodies of evidence available for our consideration. In the first place there is the social hygiene which made a healthy people and which so much impressed Herodotus. As Neuburger says, 'the attainments of the ancient Egyptians in hygiene and prophylaxis against disease ranked higher than their therapeutics. The wonderful edifice of social hygiene must undoubtedly have been built on foundations of an experience derived from the remote past.' Some facts stand out clearly. Egyptian prevention was established as a recognition that many current ailments were derived from over-feeding, from insufficient and improper feeding, or from a failure to keep the alimentary canal clean. It was observed that 'every disease is occasioned by dietary', and that means must be taken to safeguard it. It must be simple and harmless; it must be varied, bread, barley, millet, wine or beer, fish, meat, quails, fruit; it must be sound and clean, and its preparation must be cleanly; meat inspection (the beast, the viscera, and the blood) must be enforced by the priests, both before and after slaughter; the water used by the priests must be boiled or filtered. Regular habits of purgation were to form part of a hygienic custom of employing, for three consecutive days in each month, emetics and enemata for prophylactic reasons.

Then, as Diodorus observed in his review of Egyptian hygiene, 'the whole manner of life was so evenly ordered that it would appear as though it had been arranged according to rules of health by a learned physician'. The priests advised that there was to be no excess of drinking beer, no

sexual perversion or indulgence, no self-abuse, no contraceptive practices, no abortion. The clothing was to be washable linen, and the body was to be cleansed daily. The use of cosmetics was highly developed among the upper classes —for restoring hair, for keeping the skin smooth, for preserving the eyes and the teeth, for perfumery—and led at least to much attention to the body. There was prevalent a 'cleanliness cult', and much anointing of the body with oil. 'They practice circumcision for the sake of cleanliness' (Herodotus).

Attention was given to sanitation in a crude sort of way, particularly in regard to dwellings in towns and villages. Refuse was to be removed from houses. In times of epidemic prevalence the house was fumigated and perfumed. Herodotus was much impressed with the fact that in low-lying parts the inhabitants pass the night in lofty towers to escape the gnats ('wherewith the country swarms') which are unable to fly to any height on account of the winds. When this is not practicable, 'each man possesses a net instead and spreads it over the bed in which he is to rest, and creeping in goes to sleep underneath. The gnats, which if he rolls himself up in his dress or a piece of muslin are sure to bite through the covering, do not so much as attempt to pass the net.'

Another point which surprised the great traveller in the ancient world was the advanced state of the medical profession in Egypt, a characteristic also celebrated by Homer and Pliny. 'Medicine is practised among them as a plan of separation,' writes Herodotus; 'each physician treats a single disorder and no more; thus the country swarms with medical practitioners, some undertaking to cure diseases of the eye, others of the head, others again of the teeth, others of the intestines, and some those which are not local.' The medical practitioners were, with few exceptions, of the sacerdotal order, like the embalmers, but their large number and specialization drew public attention to questions of medicine and hygiene, and indicated both an advanced stage of civilization and the prevalence of a knowledge of these subjects.

I have already alluded to the opinion of Herodotus that

the Egyptians were (next to the Libyans) 'the healthiest people in the world', which he attributed to the effect of climate, a dry atmosphere without sudden changes, and a superabundance of sunlight. Apart from sun-worship, the extraordinary asset of the climate seems to have been taken for granted, and receives but little therapeutic attention in extant records. There is another factor which the student of Egyptian hygiene is apt to underestimate, namely, that much of the way of life conducive to personal health was, in Egypt, inculcated by religious ordinance which both created and used a profound and all-pervading popular psychology. The mass of men of low intellectual development can, without much mental effort, be persuaded to respond, as in control by magic and superstition, to common action in their own interest, particularly if traditional and customary. This power of ordination was enhanced by assurance of long life, good health, copious offspring, or transcendental benefit. When Herodotus looked at Egypt and saw a widespread degree of communal and personal health he was the witness of the effect of religious ritual combined with the open-air life of an agricultural community in a sunny climate. For the greatest example of ordination in the history of the ancient world was in operation before him, the Mosaic Law.

The Mosaic Law

When our forefathers spoke of the Mosaic Law they thought of 'Moses, learned in all the wisdom of the Egyptians, leading his people with deepest wisdom and confident, purposeful clarity over the road of hygiene in religious garb, thousands of years ago'. But modern inquiry and criticism have left the great figure of Moses as dim and hazy as the law which he pronounced—Mosaic in origin and texture. It is now believed that it was formulated and pronounced some time between 1400 and 1250 B.C. Its earliest records were written down, in all probability, in the tenth or ninth century by a prophet of Judah, and cast into one form somewhere about 722 B.C. In the fifth century the 'priestly narrative' was added, and thus the Pentateuch was com-

pleted some eight or nine hundred years after the Exodus. None of the constituent documents were written by Moses, though his words to the children of Israel may well have been their origin and inspiration. The book of Exodus contains the decalogue, the beginning of the law for the Israelites at the time of their departure from Egypt (written down many years after the event); the book of Leviticus, laws of hygiene for the journey through the wilderness; and Deuteronomy (the book discovered in the reign of Josiah, 621 B.C.) the confirmatory law for their settlement in a land of promise. But the Mosaic Law of the Pentateuch was further edited, amplified, and redressed before it was absorbed in the Talmud, the great Rabbinical thesaurus, which was reduced to writing by Hillel and other rabbis in the second, fourth, and sixth centuries of the present era.

We are, therefore, here in the Pentateuch dealing according to modern authorities not with the specific words or speeches of Moses, but with a miscellaneous collection of ordinations, written by different hands, at different times, and derived from various sources over a period of not less than 800 years after the death of Moses, such body of authority being further added to and embellished in the Talmud 700 years later. The Pentateuch became the book of the law (*Torah*) of the Hebrews, who were in fact the founders of public hygiene. When Moses led the Israelites at the time of the Exodus he was Egyptian in learning and experience. His task was to effect their education and emancipation for a world-wide mission, to create a theocracy and to extend it, and to provide a national code of laws for the health of body and mind. His ordinances therefore present not only a ritual in religion but a corpus of sanitary law for civil use and development, derived partly from Egypt and partly from Babylon. Speaking generally, it may be said that there were eight great principles presented in the Pentateuch code of hygiene.

1. *The institution of one day of rest in seven* (Exodus xx). 'The Sabbath Day gave tired workaday humanity a sort of permanent splint to rest upon.'
2. *Cleanliness of the human body*. Its defilement from contact with

the dead, whether man or beast; after childbirth; after issues; after venereal disease—forms and periods of purification or disinfection being prescribed. (Leviticus xi, xii, xv; Numbers xix.)

3. *The use of clean food.* The interdiction of blood, pork, and meat from unclean animals liable to parasites and disease. (Leviticus xi; Deuteronomy xiv.)
4. *The protection of water supply and food supply.* (Leviticus xi; Numbers xix.)
5. *Cleanliness, conservancy, and sanitation of camp life.* (Numbers v and xix; Leviticus iv; Deuteronomy xxiii.)
6. *The practice of circumcision.* On eighth day, at sixth or tenth year, or at twelfth year. (Leviticus xii.)
7. *Laws of sexual relationship and sexual health.* The abomination of sexual perversion. (Leviticus xviii; Deuteronomy xxii.)
8. *The prophylaxis and suppression of contagious disease.* Leprosy, its signs and symptoms, routine inspection and isolation of patient, disinfection of garments and house. (Leviticus xiii and xiv.)

Now here we have the essentials of Public Hygiene for a nomadic people and squatters, of agricultural occupation, in the climate of Egypt, Syria, and Babylonia, of traditional customs, and in a civilization at least 3,000 years old. A study of these items of practice will disclose the fact that they derive from Minoan, Assyrian, Babylonian, Indian, and Egyptian origins. They came out of the long past, and constituted a system which has come down to the present day. They are, at initiation, partly religious and partly social, yet whether subjective or objective they are wholly sanitary and hygienic. They were designed to meet the particular diseases then prevalent—leprosy (including true leprosy, psoriasis, and other kindred diseases), venereal disease, ophthalmia, scurvy, and various types of bone deformity. They were directed against bad water and unwholesome food-supplies, against refuse and fly nuisances, against the spread of infectious and contagious diseases, and against sexual perversion and its resulting disorders.

It would be difficult to say which of these eight profound and far-reaching principles has done most for the survival and betterment of mankind. Be their origin and purpose what it may, they have, each and all, accomplished an

amazing service without parallel for the physical and moral redemption of man. 'What a wealth of physical and spiritual blessing was poured upon the Jews by their day of rest', wrote Sudhoff.

'More than any other fact, it gave them strength to assert themselves among other races; and by contributing this hallowed day to Christianity and Islam, they thus imparted its hygienic blessing upon the greater part of the world. Had Judaism given nothing more to mankind than the establishment of a weekly day of rest, we should still be forced to proclaim her one of the greatest benefactors of humanity.'

This generous, and as I think truthful, testimony reminds us of Macaulay's reference in Parliament to the same point during the debate on the Ten Hours Bill for factory employees in 1847. This is what he said:

'Man, man is the great instrument that produces wealth. We are not poorer but richer because we have, through many ages, rested from our labour one day in seven. That day is not lost. While industry is suspended, while the plough lies in the furrow, while the Exchange is silent, while no smoke ascends from the factory, a process is going on quite as important to the wealth of nations as any process which is performed on more busy days. Man, the machine of machines, the machine compared with which all the contrivances of the Watts and the Arkwrights are worthless, is repairing and winding up, so that he returns to his labours on the Monday with clearer intellect, with livelier spirits, with renewed corporal vigour. Never will I believe that what makes a population stronger, and healthier, and wiser, and better, can ultimately make it poorer.'

The Mosaic Law also gave to mankind the idea of the imperative necessity of isolating those afflicted with contagious or infectious disease. The method of isolation or the particular modes of 'purification' are matters of detail. The fact of the need of both is paramount. 'The whole conception of transmission of serious disease by social intercourse with the afflicted,' adds Sudhoff, 'and of the consequent isolation of disease, became the property of the West by a religious route.' No one can reflect upon these matters without being convinced that his high praise of those ordinances is justified.

Nevertheless, it must be said that Preventive Medicine in Egypt remained for centuries in a state of arrested development, for there was little or no appreciation of the reign of natural law, of the principles of physiology, or of the vital importance of liberating science from the shackles of superstition. And yet, when we think of man's persistent search for health and survival in the land of Egypt through the immense length of thirty-five centuries, of his experience in magic, in religion, and in the dawning of science, and of his heroic and effective endeavour to find security in civic law or compelling ordinance, we cannot bring ourselves to deny him his enduring right of reward.

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III

GREEK MEDICINE AND THE GREEK SPIRIT

'*Nothing moves in the modern world that is not Greek.*'—SIR H. MAINE.

Synopsis of Lecture III

Greek Medicine comprised four movements: the Ionian philosophers, the cult of Aesculapius, the School of Hippocrates, the Alexandrian interpretation. The Physical World.

Whence the Ionians derived and what they did.
(*a*) Thales, Anaximander, Pythagoras, Heraclitus—the Milesians.
(*b*) Pythagoras, Alcmaeon, Empedocles—the Crotonians.

The healing gods of Greece. '*Men are mortal gods, and gods are immortal men.*'—Heraclitus.

Hippocrates, the Father of Medicine (460 B.C.). Cos and Cnidus. The Hippocratic Corpus, its discipline and morality (doctrine, clinical cases, precepts, aphorisms). Its principles:
(*a*) dissociation of science from magic;
(*b*) reliance upon Nature and environment as cause and healer of disease;
(*c*) organized clinical observation and diagnosis of disease on inductive basis;
(*d*) need of moral inspiration and scepticism of the unverifiable.

Diocles of Carystus as disciple of Hippocrates.

The Greek School of Alexandria (322 B.C.) and its modification of Hippocratic ideas.

The Preventive Medicine of the Greeks. Greek Education and Nurture.
(i) Universal training of youth on physiological lines.
(ii) Sanitation combined with practice of hygiene.
(iii) Restriction of unfit population.
(iv) Physical care of Greek womanhood.
(v) Advance of medical science.

The Greek spirit. What was it? '*It first clearly grasped the aims and inwardness of hygiene.*'—Sudhoff.

III

GREEK MEDICINE AND THE GREEK SPIRIT

When Sir Henry Maine said that 'nothing moves in the modern world that is not Greek', what did he mean? What is the great dividing line between the Preventive Medicine of Egypt and that of Greece? Is it not in a word this—that the Greeks introduced into the mind of the ancient world two new conceptions, rationalism and naturalism. The focal concentration in the preventive practice of Egypt, derived as it was from varied sources, is to be found as we have seen in custom and tradition inherited from magic, superstition, and religious habit and imposed upon the individual and the community by means of diverse forms of authority. The Greeks brought into the intellectual world of their day new ideals as to freedom of thought, love of beauty, and humanism, and they reached these ideals by finding the universe to be reasonable, harmonious, and cosmic. They looked at it with directness and with sanity. They awakened to its many-sidedness and attractiveness. Above all, they began a search into its naturalness, its meaning, and its cause and effect.

The Greek spirit in Medicine was not expressed in these terms, nor as an entity or a single scientific movement. It was built up from, and comprised, at least four movements, none of them mutually exclusive and none of them unmixed with alien prejudgements or foreign tradition. First, there was what came to be described as the Ionian philosophy; then there was the cult of Aesculapius, the god of health; a little later came the birth of Hippocratic Medicine; and lastly, there was the dissemination of Greek Medicine which followed in the wake of the conquests of Alexander the Great and was embodied in the Alexandrian School. It is the complex or syndrome of these four separate movements which thus constituted Greek Medicine, which made it different from everything else in the way of medical science that had appeared before, and which became the Medicine of the West and of our own times. When we

think of these movements we shall fail to understand them unless we recognize that, even geographically, they had different origins. The Ionians came from the western shore of Asia Minor where it dips down to the Aegean Sea, stretching from the traditional site of Troy in the north to Rhodes in the south. Racially they were Aryans (Indo-Persian), Minoan (Crete), and Dorian from the Balkans and the 'bronze' peoples of the Danube. They came down to the Aegean coasts of Asia Minor, and settled at Ephesus, Smyrna, Miletus, and Rhodes. The cult of Aesculapius covered the whole Greek world, Athens and the Peloponnese, and the islands and shores of the Aegean. The Hippocratic Schools were, of course, Ionian, but they sent emissaries to the toe of Italy and to Sicily; and the spread of the Greek spirit in the pathway of Alexander emanated from Alexandria as a centre.

The Physical World

What is the world made of, and how is it carried on, and why? These were the questions which puzzled the Ionians. And in their attempt to answer them they dreamed dreams and saw visions. Their wise men, or philosophers as they were afterwards called, saw, or thought they saw, a world of order and law, a cosmos, and not a world of chaos or chance. Everywhere they saw energy, changing and varying yet indestructible; everywhere they saw matter, substance, solid or fluid stuff, yet all of it built up in particular form and minute structure.

Thales of Miletus was the first of these Ionian philosophers (639–544 B.C.). His contribution was to conceive of the world and the universe as a cosmos, independent of magic, superstition, or the supernatural, and he believed that it was derived from air or water. *Anaximenes* (610–545) agreed with him, but thought air was the primary source of substance, energy, and life. *Anaximander* (611–547) carried the subject farther by differentiating man as microcosm from the world as macrocosm, holding that the cosmos consisted of inorganic matter, vegetable, animal, man. He made maps and charts and used measurement.

He was in favour of water as the primary source, and laid much store in heat and cold. These three were the chief Milesians. *Pythagoras* of Samos (580–500) was a pupil of Anaximander and had learned mythology from Pherecydes of Syros, a primitive naturalist. In 532, when he was 48 years old, he left Samos and crossed the sea to Croton in Italy, and there established a school of philosophy and mystical religion, the Pythagorean brotherhood. He believed in the cosmos, which he thought consisted of four elements (earth, fire, air, water) combined and governed by numbers and quantities—a basis of measurement and molecular combination. His aim was, by analysis, to put the Milesian theory into mathematical form, the beginning of a harmony, and his numbers introduced 'critical days' in sickness. *Heraclitus* of Ephesus, though not a pupil, was a follower of Anaximander. He believed matter was both molecular and active, having power of inward motion. He was the first metaphysician, and put microcosm before macrocosm; man and not circumstance was master; more than that, he said truth could only be found by the study of man, because man was Nature's masterpiece and the embodiment of its principles of cosmic law. In fact, 'man was the measure of all things'. He eliminated the supernatural because all things were divine. Man's duty was to know himself, for each individual differed in powers of body and sense-perception; and the elements of Nature, and the matter and energy of man's body, were transmutable. This carried him farther still, for there was, he believed, what we should call 'conservation of energy', and it was constant and persistent unless *redirected* by outside forces. All things were thus liable to change and development, the sea returned as rain, the air outside became the life of the body, and there was continual change going on in Nature as well as in man.

Thus long before the time of Hippocrates, and the great Hippocratic physicians, there were two schools of philosophy which formed a basis for Medicine—the Ionian and the Italo-Sicilian. Both were thinking about the same sort of things, the physical world around them, and both developed schools and had many medical disciples. The

Sicilian School produced *Alcmaeon* of Croton and *Empedocles* of Agrigentum. Alcmaeon (*c.* 500 B.C.) was a young contemporary of Pythagoras and is the first Greek medical author known to us. He was an anatomist, and first conceived the brain to be the organ of intellectual activity and the separate senses its means. Sense-perceptions, he taught, were fused together in the brain, associated in memories, which led to inferences, and inferences to reason. Some of his contemporaries believed that the heart was the centre of mental activity. Alcmaeon held that disease was a disturbance of the balance of body qualities and that health was the equilibrium, the physiological balance or harmony. The causes of disease he believed to be due to external agencies (starvation, plethora, fatigue) or changes in the elemental qualities of the body (heat, cold, moisture, dryness). These doctrines of the Croton School were to be developed by Hippocrates. Empedocles of Agrigentum (500–430 B.C.) influenced Alcmaeon and was, like him, a physician with a practical sense of prevention. For instance, he recommended that malaria in Sicily could be reduced by drainage of marshes, and personal hygiene improved by moderation of life. He believed the four elements (water, earth, fire, air) were represented in the body by liquid and solid, warmth and respiration. He was one of the medical philosophers who held that the heart was the centre of thought and consciousness, believed that respiration took place through the pores of the skin as well as the lungs, and that the movement of the blood was a flux and reflux like the tides of the sea. He discovered atmospheric air, as distinct from space or vapour, and believed that new bodies were formed by the combination of elements. Hence he has been called 'father of chemistry'. After Alcmaeon and Empedocles came Diogenes of Apollonia, Akron, Democritus of Abdera in Thrace, and Democedes of Croton.

These Ionians, whether of Ionia or Croton, however varied, novel and strange their views, seem very near to us. Indeed they dreamt of things realized only in our own day. They were cosmologists, dreamers of a world of law and order in which they sought a synthesis; they were

analytic, yet also constructive; they wedded theory to practice and were seers and inventors; they conceived the idea of the indestructibility of energy, of the idea of atomic structure, of measurement and its methods; they were rationalists and the beginners of anatomy and physiology, of morphology and function; they believed in nature, not custom, and thus became the founders of the science of Medicine. Their work was new and independent, even though it may have derived from 'a Babylonian nutritive stratum'. They tried to harmonize, and even assimilate man with Nature, and though they failed, they believed that *to know man is to know all things* and that his mental and spiritual faculties are his supreme endowment, that he is the crown and not only the creature of Nature. They were the first to sing the new song of man's inheritance and of his unconquerable mind. Their hunger and thirst was for Truth—as Keats said:

> To bear all naked truths,
> And to envisage circumstance, all calm.

It is not extravagant to say that their eyes beheld the morning star, and their feet were beautiful upon the mountains. 'The mother who reared and suckled Hellenic medicine', said Sudhoff, 'was the Ionian philosophy.'

Hippocrates and his Ideas of Medicine

Greek Medicine therefore, though it was not built upon it, descended partly from Homeric and post-Homeric secular surgery and partly from early folk-lore and magic blended with religious belief. The healing gods of Greece were in some cases derived from Egypt. There was, however, less domination from the underworld and from the priests, and more susceptibility to the needs and thoughts of men; a greater variety of function was attributed to each god. Athena was for instance god of the city, of Hygiene, and of Ophthalmitis! 'Men are mortal gods', said Heraclitus, 'and gods are immortal men.' Greece had forty or fifty healing deities, but Aesculapius became the chief. He was first mentioned by Homer as 'a blameless physician',

subsequently deified as son of Apollo. Tradition assigns his life to a period earlier than the Trojan war and refers him to Thessaly, where Cheiron taught him. He had two sons and four daughters, the most famous of whom was *Hygieia*, who represented health rather than healing. She received suppliants and cared for the sacred serpents. A number of temples were dedicated to Aesculapius, the sites of which were chosen for their salubrity, pure air and water, and general attractiveness. I have already described their lay-out. The healing consisted in the blessing of the god associated with hygienic living, fresh air, rest, diet, regulated exercise, and baths, with bleeding, herbs, massage, and serpent ritual. The lick of the sacred serpent had not only generic therapeutic value, but was also held to be specific for certain diseases.

Into this setting came the physical philosophies of the Ionians and the rational medicine of Hippocrates which sought to free itself both from superstition and from empiricism. Hippocrates and his contemporaries learned much from the cult of Aesculapius—to which I referred in the first lecture—its hygiene, its herbs, and its votive offerings. For the physician priest in the temples and the physician outside both looked to Aesculapius as the divine exemplar. But Hippocrates had his own message.

Hippocrates, or, as Aristotle calls him, 'the great Hippocrates', was born at Cos, a Doric island on the Ionian shore, in 460 B.C. He was thus contemporary with the immortal poets, Sophocles, Euripides, Aristophanes, and Pindar, with Socrates and Plato, with Herodotus and Thucydides, with Pericles the statesman and Phidias the sculptor—the heroes, poets, philosophers, historians, and statesmen of the golden age of Greece. Hippocrates was one with them. He probably belonged to a guild of physicians called the Asclepiadae, was the son of Heraclides, and his teachers were his father (a physician) and Herodicus (an arch-gymnast). He practised medicine in the sunny island of Cos, travelled in various parts of Greece, and was the friend of Democritus of Abdera, the atomist. He lived a long life and gathered round him a number of pupils and disciples whom he instructed.

The teachings of Hippocrates dominated the three great schools of his time, Cos itself, Cnidus opposite to it on the mainland, and the Italo-Sicilian centred across the sea in Croton and Sicily. In each there were religious, philosophical, and rational elements. The Hippocratic corpus of knowledge was expressed in a literature of books, mostly lost. Among the books of the Hippocratic collection are *Ancient Medicine*; *Airs, Waters, and Places*; *Epidemics*; *The Oath*; *Precepts*; *Nutriment*; *Prognostic*; *The Art*; and *Aphorisms*. It is not known with any certainty which, if any, of these were actually the personal work of Hippocrates himself. His was indeed a name without writings. All we can say is that the books and remnants of books contain something new in that age. They record observations, clinical histories, epidemiological phenomena. The trend of these works is concerned with the natural clinical course of disease and its recording; with the causation of sickness by disturbance of physical balance, due to internal factors such as irritations, poisons, and infections, or due to external environment, e.g. climate, season, winds, waters, soil, site of house, mode of life, and occupation of the patient; with the progress of disease due to the inherent nature of the body versus its disturbing factors; with 'critical days' at fixed dates in this conflict between the body and its reactions, used as means of prognosis; and with the duty of the physician in facilitating and liberating the inherent powers of the body, by fortifying them by expectant treatment, and by rational or empirical use of medicaments, baths, blood-letting, hygiene, diet, and rest. By his own life, conduct, and character Hippocrates inspired his disciples with a high discipline and professional ethic. This is illustrated in his integrity of practice, his accuracy of observation, as well as by his precepts, aphorisms, and the Hippocratic Oath.

The Principles of Hippocrates

The Hippocratic corpus was, of course, interpreted, controverted, and defended by the contemporaries of Hippocrates (Diocles, Chrysippus, and others), by various

schools of physicians, and by Galen. The great outstanding principles at the back of the corpus and the practice and teaching of Hippocrates were four in number:

(1) There was dissociation of scientific method from priestcraft, magic, supernaturalism, and theurgy. In one word, the doctrine and practice of Hippocratic Medicine was *rational.*

(2) Reliance was placed upon the inherent physiological faculties and powers of the body to predispose to disease *and to heal it.* Disease is not an external entity, but a reaction of the living body to its environment. 'Nature is the healer of disease' and its causation is always according to natural law and not caprice.

> 'I hold it is necessary to know which diseased states arise from powers [or functions] and which from structures in the human body. . . . I mean to possess this information, *what man is and by what causes he is made.* This at least I think a physician must know about natural science, if he is going to perform aught of his duty, what man is in relation to foods and drinks, and to habits generally, and what will be the effects of each on each individual' (*Ancient Medicine*).

Treatment and prevention are provided, therefore, for the assistance of Nature (and not in opposition to it), by the removal of hindrances and by strengthening the body and fortifying its capacity to resist, viz.: by appropriate application of air and water; by sound and healthy environment; by a way of life; by diet, exercise, rest, baths, purgation, massage, venesection, &c.

(3) The organization of clinical observation and diagnosis is to be an *inductive method* and to be associated with experience, and with the operation of the law of cause and effect.

(4) In order to understand man and the ailments of his body, it is necessary to have ethical and social concepts, comprehension and a sense of values (because of the 'divinity' of Nature), and be sceptical of the unverifiable. 'In my opinion these maladies, like all other things, are divine; no one thing is more divine or more human than another, for all things are alike divine; yet each one has its own natural properties, and cannot come into existence without natural causes' (*Airs, Waters, and Places*).

It will be seen at once that these four principles, emerging in the fifth century before Christ, constitute something like a geological 'out-crop'. Nothing had yet appeared exactly like them in the previous history of mankind. They represented a complete break with a gigantic past of 4,000 years, an epoch which they ended. They marked the ultimate doom of prejudice, superstition, and tradition as the basis of the medical art, and they provided in its stead a living foundation on which to build an enduring scientific method. As they ended one epoch so they began another. As there had been nothing like them before, so there was to be nothing like them again for a thousand years. In the whole range of the history of Medicine there were two such mental revolutions; neither of them began in a moment, and neither of them was without its forerunners. Yet both of them stand up as peaks of human creativeness, the emergence of the Greek spirit, and, ten centuries later, the Renaissance of the West. What caused them? Was it a supernatural phenomenon, or was it perhaps political, or even social? Was it the work of one man? I think the answers to these questions must be No. Eight hundred years had gone by since the age of Moses; a century had passed since the reforms of Solon; three generations since Pisistratus became tyrant; fifty years since the Persian zenith. It was none of these things. *It was the awakening of the human mind by the Ionian seers.* It was they who had asked, without prejudice or preconceived ideas, what is the world made of? and how is it carried on, and why?

Let us consider what these high principles meant in the medical art. They meant that when the Hippocratic physician stood face to face with his patient he must say to all magic and make-believe, 'Get thee behind me, Satan'. Then he must, without prejudice, proceed to examine the body and observe its changes, signs, and symptoms. He must ask whence came this particular body and whence the marks upon it. He must find and verify the *facts*, classify the facts, deduce from the facts, and standardize his deductions by his experience. Nor is this all. He must know the environment of his patient—all the

current influences bearing upon this particular human body, ancestry, climate, soil, occupation, diet, habit—for his task is to relate the signs and symptoms, the reaction, which he observes in this body, to the complex and multitudinous influences of the environment in which it exists.

'In the beginning,' says the ancient writer, 'whoever would wish to pursue properly the science of medicine must in the first place consider the characteristic effects produced by the *seasons* of the year, remembering that not only does each season in any year differ from the others, but that the same seasons differ in successive years. And then the *airs and winds*; such qualities as are common to all countries and such as pertain to particular localities. And then the properties and qualities of *waters*; for, as these differ in their physical characters, so do they differ in their action upon the body. So, too, must be considered the *situation of towns*, with regard to the prevailing winds, and to the rising sun. And the waters used by the inhabitants: whether marshy and soft, or hard, and from rocks, or salt, and unfit for cooking. And the *habits of the inhabitants*: their avocations, and whether they be eaters and drinkers to excess; and indolent or industrious, vigorous, frugal, and abstemious. From these things must he proceed to investigate certain others in particular, so that, when he come into a strange city he will understand the diseases there endemic, and the modifications of common maladies that there obtain' (*Airs, Waters, and Places*).

Lastly, he must ask himself, what is this man's own nature—body, mind, and spirit—doing to heal his disease and harmonize his disharmony; and what can be done to aid and abet and fortify such natural powers. For this sickness is not something theurgic, penal, or supernatural, *it is caused*, and in many cases it is preventable. It is as 'natural' as health, indeed it is equally 'divine'.

The Medical Art of Hippocrates

Now it is on these grounds that the simple clinical notes left behind in the Hippocratic collection are of such deep interest to us. They are almost as scrappy and incomplete as the record cards of a modern insurance practitioner, yet are they living documents with the dust of 2,500 years upon them. I will quote one or two examples from the *Epidemics*, and to introduce them we will have the general comment

of the writer, and as we read it we may compare it in our mind's eye with the notes on patients in the Egyptian papyri of a thousand years earlier. Here is the comment:

'The following were the circumstances attending the diseases, from which I framed my judgments, learning from the common nature of all and the particular nature of the individual, from the disease, the patient, the regimen prescribed and the prescriber—for these make a diagnosis more favourable or less; from the constitution, both as a whole and with respect to the parts, of the weather and of each region; from the custom, mode of life, practices and ages of each patient; from talk, manner, silence, thoughts, sleep or absence of sleep, the nature and time of dreams, pluckings, scratchings, tears; from the exacerbations, stools, urine, sputa, vomit, the antecedents and consequents of each member in the successions of diseases; and the abscessions to a fatal issue or a crisis, sweat, rigor, chill, cough, sneezes, hiccoughs, breathing, belchings, flatulence, silent or noisy, haemorrhages, and haemorrhoids. From these things must we consider what their consequents also will be. . . .

'Declare the past, diagnose the present, foretell the future; practise these arts. As to diseases, make a habit of two things—to help, and at least to do no harm. The art has three factors, the disease, the patient, the physician. The physician is the servant of the art. The patient must co-operate with the physician in combating the disease' (*Epidemics*, i).

It is clear that the writer sets himself to learn from 'the common nature of all' as well as 'the particular nature of the individual'. With this introduction we may look at some examples of the Hippocratic physician's notes:

Case I

Philiscus lived by a wall. He took to his bed with acute fever on the first day and sweating; night uncomfortable.

Second day. General exacerbation, later a small clyster moved the bowels well. A restful night. *Third day*. Early and until midday he appeared to have lost the fever; but towards evening acute fever with sweating; thirst; dry tongue; black urine. An uncomfortable night, without sleep; completely out of his mind. *Fourth day*. All symptoms exacerbated; black urine; a more comfortable night, and urine of a better colour.

Fifth day. About midday slight epistaxis of unmixed blood. Urine varied, with scattered, round particles suspended in it, resembling semen; they did not settle. On the application of a

suppository the patient passed, with flatulence, scanty excreta. A distressing night, snatches of sleep, irrational talk; extremities everywhere cold, and would not get warm again; black urine; snatches of sleep towards dawn; speechless; cold sweat; extremities livid.

About midday on the *sixth day* the patient died. The breathing throughout, as though he were recollecting to do it, was rare and large. Spleen raised in a round swelling; cold sweats all the time. The exacerbations on even days.

Case II

Silenus lived on Broadway near the place of Eualcidas. After overexertion, drinking, and exercises at the wrong time he was attacked by fever. He began by having pains in the loins, with heaviness in the head and tightness of the neck. From the bowels on the first day there passed copious discharges of bilious matter, unmixed, frothy, and highly coloured. Urine black, with a black sediment; thirst, tongue dry; no sleep at night.

Second day. Acute fever, stools more copious, thinner, frothy, urine black; uncomfortable night; slightly out of his mind. *Third day.* General exacerbation; oblong tightness of the hypochondrium, soft underneath, extending on both sides to the navel; stools thin, blackish; urine turbid, blackish; no sleep at night; much rambling, laughter, singing; no power of restraining himself. . . .

Sixth day. Slight sweats about the head; extremities cold and livid; much tossing; nothing passed from the bowels; urine suppressed; acute fever. *Seventh day.* Speechless; extremities would no longer get warm; no urine. *Eighth day.* Cold sweat all over; red spots with sweat, round, small, like acne, which persisted without subsiding. From the bowels with slight stimulus there came a copious discharge of solid stools, thin, as it were unconcocted, painful. Urine painful and irritating. Extremities grow a little warmer; fitful sleep; coma; speechlessness; thin transparent urine. *Tenth day.* Took no drink; coma; fitful sleep; discharges from the bowels similar; had a copious discharge of thickish urine, which on standing left a farinaceous, white deposit; extremities again cold. *Eleventh day.* Death. From the beginning the breathing in this case was throughout rare and large. Continuous throbbing of the hypocardium. Age about 20 years.

Case VII

In Abdera, the maiden who lay sick by the Sacred Way was seized with a fever of the ardent type. She was thirsty and sleepless. Menstruation occurred for the first time. *Sixth day.* Much nausea;

redness; shivering, restlessness. *Seventh day*. Same symptoms. Urine thin but of good colour; no trouble in the bowels. *Eighth day*. Deafness; acute fever; sleeplessness; nausea; shivering; was rational; urine similar. *Ninth day*. Same symptoms, and also on the following days. The deafness persisted. *Fourteenth day*. Reason disturbed; the fever subsided. *Seventeenth day*. Copious epistaxis; the deafness improved a little. On the following days nausea and deafness, while there was also delirium. *Twentieth day*. Pain in the feet; deafness; the delirium ceased; slight epistaxis; sweating; no fever. *Twenty-fourth day*. The fever returned, with the deafness; pain in feet persisted; delirium. *Twenty-seventh day*. Copious sweating; no fever; the deafness ceased; the pain in the feet remained, but in other respects there was a perfect crisis.

Case XIV

Melidia, who lay sick by the temple of Hera, began to suffer violent pain in the head, neck, and chest. Immediately she was attacked by acute fever, and there followed a slight menstrual flow. There were continuous pains in all these parts. *Sixth day*. Coma; nausea; shivering; flushed cheeks; slight delirium. *Seventh day*. Sweat; intermittence of fever; the pains persisted; relapse; snatches of sleep; urine throughout of good colour but thin; stools thin, bilious, irritating, black and of bad odour; sediment in the urine white and smooth; sweating. *Eleventh day*. Perfect crisis.

Case XV

In Thasos, the wife of Delearces, who lay sick on the plain, was seized after a grief with an acute fever with shivering. From the beginning she would wrap herself up, and throughout, without speaking a word, she would fumble, pluck, scratch, pick hairs, weep and then laugh, but she did not sleep; though stimulated, the bowels passed nothing. She drank a little when the attendants suggested it. Urine thin and scanty; fever slight to the touch; coldness of the extremities. *Ninth day*. Much wandering followed by return of reason; silent. *Fourteenth day*. Respiration rare and large with long intervals, becoming afterwards short. *Seventeenth day*. Bowels under a stimulus passed disordered matters, then her very drink passed unchanged; nothing coagulated. The patient noticed nothing; the skin tense and dry. *Twentieth day*. Much rambling followed by recovery of reason; speechless; respiration short. *Twenty-first day*. Death. The respiration of this patient throughout was rare and large; took no notice of anything; she constantly wrapped herself up; either much rambling or silence throughout.

Such clinical records, obviously honest and succinct, without comment or prejudice, were not rare in the Grecian world, and differed not only in accord with the physician and his patient but in response to different clinical doctrines and methods. They differed from the far more numerous records of the patients in the healing temples, which were superstitious, explanatory, and justifying, and less particular and exact. Of both Sophocles wrote that 'skill of art may teach him to escape from depths of fell disease incurable'.

Medical families, guilds, and schools arose in due course at Athens, Croton, Cyrene, Smyrna, Pergamum, Ephesus, Rhodes, and elsewhere. Among the more celebrated was that on the island of Cos where Hippocrates practised, and that at Cnidus, on the mainland opposite to Cos. These two neighbouring Schools are of interest because of the different doctrines which they professed. They might both claim to be Hippocratic, but Cos stood more for 'the pure milk of the word' than Cnidus. The principle adopted by both was the broad view, that to know the nature of man the physician must know the nature of all things, but the Coans paid regard to the patient as an individual, the general state of his health, the external natural conditions of his whole environment, and the prognosis. They studied the whole man and relied upon the *vis medicatrix naturae*, seeing his disease as a reactionary process rather than an entity. The Cnidian School, on the other hand, were more disposed to give attention to diagnosis of the disease as such, the organ affected and the local means of its relief. They studied the particular pathology rather than the general, relying for healing upon therapeutic means rather than natural hygiene and resistance of the body. But probably the historian has sometimes attempted rather too much differentiation between the two. What mostly concerns us is that neither Coan nor Cnidian, nor indeed the Hippocratic corpus, has much directly to say about Preventive Medicine, nor is there much indication of special prevention in the clinical records of that time.

But here we must be careful not to allow ourselves to be misled. For whilst there are few outward signs of the prac-

SITE OF TEMPLE OF AESCULAPIUS, ISLAND OF COS

By courtesy of FERDINAND ENKE

SITE OF TEMPLE OF AESCULAPIUS ON ISLAND OF COS (CNIDUS OPPOSITE)

tice of preventive methods, I would go so far as to say that we shall find the very substance and core of the fundamental principles of Preventive Medicine in Hippocratic doctrine. Sanitation and drainage, isolation of the infectious patient and disinfection, even a muzzling order for dogs, are, it is true, methods of Preventive Medicine, but they are not the principles. They are examples and not the bed-rock ideas upon which Preventive Medicine is founded. If you recall the definition of our subject at the opening of the first lecture, its fundamental ideas could scarcely be better expressed than in the four Hippocratic principles to which I referred just now. Rationalism applied to scientific method, reliance on the inherent physiological faculties of the body to predispose to disease and to resist it, inductive logic, and an understanding of social and moral values—these are among the essential things which constitute the beginning of any true understanding of Preventive Medicine. They give it *direction*. It is the application and interpretation of these principles through the centuries which have given us in modern times the means and purpose of the great public services in behalf of communal health. Yet the four principles themselves were not formulated anywhere in the world of men until the arrival of Ionian and Hippocratic medicine. In origin they are Greek. They are first discernible in the Hippocratic books, in the clinical observation and records, and in the disciples of Hippocrates. It is their presence, and the practice of them, in these forms which separates the whole of this epoch from all that went before it.

Diocles of Carystus

Soon after the death of Hippocrates there was born in 350 B.C. at Carystus at the south-east part of Euboea in the Ionian Sea his famous disciple Diocles. He lived at Athens and was the friend of Plato and teacher of Praxagoras of Cos (who himself taught Herophilus of Alexandria). He became the practical interpreter of Hippocrates in Preventive Medicine. Devoting himself to the study of embryology, materia medica (deadly drugs), pathology, and clinical

medicine, he became one of the most accomplished physicians of his time. He wrote the first work on anatomy, the first herbal, and the first text-book on hygiene. He believed the health of the individual depended upon the balance of opposites in the body and that ill-health was attributable to unfavourable environment and disturbance of the humours. As preventive methods he particularly commended moderation and temperance in all things, diet, exercise (but not too much), rest, baths, and a way of life which secured the harmonious integration of the bodily functions. Some of his physiology about the four humours (blood, phlegm, black and yellow bile) and the four elements (fire, water, earth, air), the pneuma, and the heart as the seat of intelligence and sensation is fanciful; but his emphasis on the effect of unfavourable environment and his anatomical knowledge of animals were sound. He urges good sanitation, that the house should be cool and airy, the clothing appropriate to the season, and the drinking water wholesome. He is defiant of all magic and priestcraft, and claims that accurate diagnosis is better than any sort of intuition. No man of the Hippocratic time held more enlightened views of personal and communal health as the answer to disease. He, more than any other, carried forward the central idea of Ionian hygiene, man as a developing organism in harmony with Nature, man's autonomy being one with that of Nature, and physio-therapeutics being both natural and rational. With Diocles the healthy habit and the open air 'sanatorium' were always preferred to drugs, and it is believed he gave us the name and idea of Hygiene. He became, with Philiston and Plato, one of the links between the Ionian School and Alexandria.

Greek Medicine in Alexandria

In the summer of 323 B.C. Alexander the Great lay dead in Babylon at the age of 32 years. He was the son of Philip of Macedonia, and among his teachers had been Lysimachus of Cos the surgeon, and Aristotle the biologist. He was 20 years old when he succeeded his father in throne and ambition, and promptly set about the Hellenic conquest of

Asia. By 331 he had conquered Syria and Egypt, and had founded Alexandria.

The next year he appointed his half-brother, the enlightened Ptolemy Soter of Lagus in Macedonia, as governor. Educated in Greek literature and science, it was he who founded the medical school that was to become so famous from 322 B.C. to A.D. 641. To the university there was attached a museum and a library, which was later destroyed by fire during the siege by Julius Caesar, being replaced by the library of Pergamum sent by Antony at the request of Cleopatra, a strange irony of events. This Alexandrian library suffered a second destruction under Theodosius, who wished to exterminate paganism, in A.D. 391, and its remnants were finished off by those who desired to exterminate Christianity at the time of the Islamic invasion in the seventh century. Ptolemy, however, was the man who started this unhappy but world-renowned library, and by its means directly aided the spread of Greek learning. He brought great teachers as well as books to Alexandria, including Euclid, Herophilus of Cos, and Erasistratus of Cnidus, disciples respectively of the two Hippocrateans, Diocles and Chrysippus. Thus was the seed sown.

By his conquests Alexander brought together two continents, and both, particularly Asia, were the gainers. For the language, arts, literature, science, and humanism of Greece were introduced into the East, as was Oriental learning to the Alexandrian School. By the first Ptolemy Greek medicine was established in Alexandria at the gates of East and West, and in 400 years was thus prepared to capture the intellect of Rome. It is a wonderful story of transmission, though it was in a few centuries to be eclipsed. Herophilus, the great utilitarian anatomist who dissected the human body and first established the science of dietetics and counted the pulse, and Erasistratus, the speculative physiologist who nearly discovered the circulation of the blood and practised autopsies to ascertain the cause of death, were the two pioneers who made Alexandria the vanguard of scientific Medicine after its decline in other parts of the Greek world, and pushed forward anatomy,

physiology, and hygiene. Erasistratus, like Diocles, taught that health consisted in the balance and stability of function, and disease in its perversion; and he was the first to urge the importance of forestalling deviation from such equilibrium, 'thus is the skill of the physician most useful and most successful'. Working together in the second century B.C. they moved forward the appreciation of Preventive Medicine and were only restricted by the lack of some of the instruments of precision of our own age. 'Without health', wrote Herophilus in his *Dietetics*, 'wisdom is darkened, art eclipsed, strength disabled, riches worthless, and reason impotent.'

Lastly, it was in Alexandria that Greek Medicine became organized. Here Coan and Cnidian met. If one takes a map of the Greek world and places upon it the names of some fifty or sixty of the pioneers in Medicine one finds that they are widely scattered—Asia Minor, the Ionian coast, eight or ten of the islands of the Aegean, Athens, the Italo-Sicilian School, but most of all concentrated in Alexandria, where for a quarter of a millennium Medicine found a co-operative focus, and where it was organized as a profession and systematized as an art. Magic and the occult were reduced—for even yet they are not dead—the atomic theory began steadily to displace the humoral, human dissection and the autopsy were introduced, anatomy and surgery rapidly advanced, the brain won its hegemony over the heart, venesection and vigorous purgation were brought into a minor place, and above all the importance of the prevention of disease received attention. 'There were for the wiser Greek physician', wrote Sir Clifford Allbutt, 'three factors of safety: he was free from magic, he never forgot to treat the individual, he was a master of hygiene.'

As Babylonian astrology and the Mosaic Law gave us a weekly day of rest, and Jewish ordination the first direct prophylaxis of disease—the two outstanding examples of early cult hygiene—it must be said of Greece that it gave us (i) Hippocratic Medicine and (ii) the kind of social education which ensures national health. I must now turn therefore

to say a few words on this second Greek contribution to the rise of Preventive Medicine.

Greek Education and Nurture

What was it that produced the Golden Age of the fifth century in Greece? Here was an amazing period of great men and of events which changed the history of the human family. 'Why should all this capacity flower just at Athens and just at that time?' Solon had governed in a reformed Athens a hundred years before, the Persians had conquered Asia and Egypt, and the Peloponnesian League had been established. Did these create the fruitful age? Thales of Miletus, Pythagoras, and the other great Ionians had lived and worked. Had the birth of pioneers and thinkers suddenly emerged as a biological phenomenon?

It is an ancient puzzle, almost a mystery. Yet not absolutely so. For there had been a leaven in ferment, largely unseen, and of which men were barely conscious, a leaven of *social evolution*. The average of the human mind, its innate capacity, is remarkably steady; what bring it to fruition, as we have seen, are social circumstance and social education, a responsive and inquisitive temperament, a spirit both secular and free. As we trace the slow rise of Preventive Medicine over the centuries we shall discover as elsewhere, ebb and flow, ups and downs, here something won for advance, there something lost to retrogression, here a time of great light and hope, followed by aftertimes of darkness and despair. Now the glorious morning of Greek renaissance was due to social emancipation which brought to the human mind high questionings. From these questionings arose the new thoughts of Medicine, and we naturally put them first in our minds, and say the fifth century gave us Hippocrates and the Hippocratic collection of ideas and of doctrine. That is true.

But there was a still greater ferment, a more seminal and reproductive leaven at work, and it was nothing less than a step forward in the social apprehension of the Greeks, an education of the whole man, an equipment of body and mind, which did more for the survival of man and his

extension on the earth than all the magic, superstition, and religious ordination which had lain upon him like a thraldom for thirty centuries. It did not achieve its effects at once, indeed it has not fully achieved them yet. But it directed and set the great business agoing. And the great business, lying far beyond the reach and orbit of the Hippocratic doctors—or for the matter of that any doctors in any period of civilization—was *the education of man, his distribution in the world, and his reactions to it.* Thus when we endeavour to gauge the part played by the Greeks in the growth and development of Preventive Medicine we must, as in measuring all consummate art, give it both time and space, not anchoring only in a particular medical doctrine or discovery, but giving due place to popular education, to hygienic vision, and to social comprehension.

It has been said, and I think truly, that education and culture made Greece. But we must notice that it was not what we in these days describe as education and culture. There was no national system of education in Greece in the generative period of the fifth century, and little or nothing of the comfort, luxury, and amenity of the culture similar to that which we have in England to-day. There was indeed education, and its principles were subsequently interpreted and glorified by Socrates, Plato, and Aristotle, but it was not national in extent or in administration, not compulsory, not universal, not uniform, not rate-aided, not literary or technical. *It was a nurture*, a nurture in character of body and mind, which was designed to make good citizens and reliable soldiers. Athens was a city-state, and that is perhaps its chief legacy, for out of that came its literature and art, its science and energy. These cities were not like our cities, monotonous collections of industrial population herded together for commercial purpose and jointly forming the bulk of a nation. The city was a *state*; it was composed of cultivators of the soil; it was a centre of nurture, discipline, and religion, where the people 'set up house together'; and it was a fortress to be defended, and all its men were, as patriots, to be always ready to fight. The Greeks had learned that, though love of country may make

men brave, it is only by organization that they can be made strong. They organized with a loose hand and as occasion and opportunity demanded; and as their city was narrowly circumscribed its population must be kept within bounds.

In the city-state of Athens school education in the first three-quarters of the fifth century was available from 6 to 14 years of age. It was for boys only, and even so not for the children of slaves and serfs. It included *letters* (reading, writing, and dictation), *music* (the lyre and singing), and *gymnastics*. At the age of 18 every youth began two years of physical training for war. Some of the physical training was overdone and over-specialized, particularly after the age of 20 and when devoted to competitions in the festival games. Against such specialization, though supported by Pindar, Xenophanes and Euripides protested, a protest supported long afterwards by Galen. In the Periclean age secondary education, including gymnastics, was introduced for some boys from 14 to 18, when they entered upon military training. Of the three grades, primary (6–14), secondary (14–18), and tertiary (military) (18–20), the first had been authorized since the time of Solon but was not universal, the second was entirely voluntary and for the richer classes, and the third only was both compulsory and provided by the State, the gymnasia and palaistra being built at public expense. This is the 'system' of education extolled in the *Republic* of Plato. The necessity of letters is obvious; the music provided harmony and rhythm, the balanced mind; the physical training (consisting of running, jumping, discus and javelin throwing, wrestling, swimming, riding, dancing, &c.), combined as it was with physiological hygiene and dietary, with baths, massage, rest, and sleep, was the most thorough and continuous of the subjects of the curriculum, gave physical health and strength of body, and was a 'test of character'. This is what Plato says:

'the conduct of a man in his exercise is a very important test of his character; and those who establish a system of education in music and gymnastic are not actuated by the purpose of applying the one to improvement of the soul and the other to that of the body. They introduce both mainly for the sake of the soul.'

But Pericles spoke even better. He claimed that, 'our city as a whole is an education', and he justified his claim, as we shall remember in the Funeral Oration (in 439 B.C.), by saying that the effect of such civic influence was 'independence of spirit, many-sidedness of attainment, self-reliance in limb and brain'. It furnished 'the fighter's daring, the wise man's understanding of his duty, and the good man's self-discipline in its performance', in short, 'the good life, from its first signs of power to its final consummation'.

For a city always in training for war and for competition in capacity with its neighbours this was everything. From it sprang liberty, goodness, beauty, knowledge, and justice. 'We are lovers of beauty without extravagance', he told the mothers mourning for their dead sons, 'and lovers of wisdom without unmanliness.' He could have added that upon such civic influence is based the whole, that is the healthy, man. It engenders the *discipline*, *orderliness*, *and way of life* which alone ensure all-round health of a whole man, body and mind, and of a whole people. It gives self-control, and guides youth to the supreme goal of the Greek philosophy represented in their twofold ideal: *Know thyself and be moderate.*

The attempt of the Athenians to control the population of their State was a subsidiary problem which we must not entirely overlook, as it becomes an important problem as the world gets older. The city-states, like the hill-towns of Italy, were rigidly circumscribed in area. All too often they were unwholesome. Athens is a case in point—a backward insanitary town, with a limited water-supply and no sewers, mean streets, and 'squalid magnificence'—for which it paid the terrible price of the plague in 430. Such limitations meant a necessary restriction in population, appropriate for the size of the town, for feeding, and for defence. There were some natural means of restriction such as the current high death-rate and the prevalence of war. The State itself prescribed within reasonable limits a fixed number of the population for each city-state, and it encouraged or favoured means for the disposal of the sur-

plus. The best method was emigration to other cities or to the numerous Greek colonies being established between the eighth and sixth centuries, for thus the Empire and its national ideals were extended. But other means were tried and it is instructive to remember their trial so long ago. There was the exclusion of aliens or restrictions upon their marriage, the postponement of the age of marriage, methods of birth-control, the discretion of the father whether the newborn infant should be allowed to live, the 'pot-exposure' of female infants, and the rejection of the crippled or delicate child. Not all these artificial methods won or held the general assent of the Athenians, nor did they prove in practice either expedient or satisfactory. They remain on record as early attempts to control the size and distribution of population.

The enduring lessons in Preventive Medicine which Greece left as part of its legacy are, then, to be found first in the Ionian conception of the physical elements of a cosmic world of Nature; secondly, in the use of these elements—air, water, heat, cold—in the practice of hygiene and as therapeutic means; thirdly, in the vital principles expressed in the Hippocratic corpus, and fourthly, in the application of Hygiene to the education and culture of its youth.

Physical exercises constitute to-day an essential element of primary and secondary education in the West. They sprang from the Greeks, and they form an important part of the foundation of personal and national health. 'It was the Greek spirit', wrote Sudhoff, 'that first clearly grasped the aims and inwardness of hygiene. This fact alone would extend the field of its history over 2,500 years—a mighty space of time indeed.' These were their four supreme contributions, and much perspicacity and genius lay behind the methods adopted to express them. Town-planning and sanitation, admission of sunlight to houses, water-supply, and sewage disposal were considered and regulated, but they did not approach the achievements of the public sanitation of Rome. Yet the science of Rome was Greek. The Greek cities were small, often built on hill-sides, and

contrived primarily for war purposes. Much greater than any environmental development was the evolution of man; and, especially in Alexandria, Greek Medicine became organized as a profession of inductive science and systematized as an art.

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IV

HOW GREEK MEDICINE REACHED ENGLAND

Synopsis of Lecture IV

Greek Medicine (Ionian, Hippocratic, Alexandrian) did not and could not remain static, nor even purely Hippocratic. Sects arose expressive of specialized opinion, and the learning of the Greeks was disseminated in three directions.

(i) Greek Medicine in Rome: Galen of Pergamum (A.D. 130–201). For Rome Galen, an Alexandrian Greek, was an episode, for the Middle Ages an epoch. His work and influence as a compiler of hygienic knowledge. Before and after his day the Empire practised Greek hygiene.

The organizing and administrative power of Rome as a vehicle of Greek hygiene and sanitation.

(ii) After decline of Western Roman Empire, Greek Medicine survived in the Byzantine Empire. Nestorius, heretic Patriarch of Constantinople (428) and the Nestorian Church; its movement eastwards through Syria to Edessa in Mesopotamia and to Gondisapor in Persia. Mahomet (622) and the Mohammedan expansion. Investment of Arabia, invasion of Persia, Egypt, Syria, North Africa, Spain, and France to gates of Tours (732). Entrenchment in Spain and establishment of Western Caliphate (755) with Cordova as capital, and Eastern Caliphate with Bagdad as capital. After Saracen armies came Arabian Medicine.

Arabian Medicine was a transmitted and transmuted Greek Medicine with some Arabic additions. Johannitius, Rhazes, and Avicenna in the East, and Albucasis, Averroes, and Maimonides in the West. Cordova, Granada, Seville, and Toledo: Montpellier. What was it that the Arabs thus brought to Europe?

(iii) Magna Graecia and the Italo-Sicilian stream. Salerno, first Hippocratic Medical School in Europe. What it did for Preventive Medicine.

IV

HOW GREEK MEDICINE REACHED ENGLAND

THE next question we have to consider is how Greek Medicine reached England. It was by a long and tortuous route, indeed by several routes. And happily some of our Medicine was home-made and indigenous. In early England medical practice was Anglo-Saxon, and, from the time of Bede, Byzantine; with the Normans came Arabian Medicine until the Reformation, afterwards inspired by Greek. Over it all brooded the great figure of Galen, the most dominating and continuous influence for a thousand years. In thinking of this long-drawn-out period we must keep a vigilant outlook if we would detect the signs of the rise of Preventive Medicine, for though numerous they are obscure and often concealed.

I remember Sir Clifford Allbutt used to say that the growth of the study of Medicine in the ancient world depended on *trade centres*, *libraries*, and *teachers*. There are many interesting examples of this. But its advance also followed invading armies and exploring argosies; it was carried by religious sects and pagan philosophies, promulgated by monks and missionaries, and spread by nomadic doctors, naturalists, translators, and scholars; and it was conveyed not only by cargoes but by the arts and crafts, by painting and sculpture. Various and diverse beyond belief have been the means by which the art of Medicine has been learned by mankind.

The Greeks inherited much, but they handed on still more. Nor, as we have seen, was their legacy so much a corpus of knowledge as a tendency, a direction, a method of experimental science. Even so their total contribution was, in large degree, a development or interpretation of what they had received, partly in the form of magic, superstition, and anthropomorphic religion, and partly in the form of the Ionian conceptions of the elements of the physical world. The emergence of Hippocratic Medicine was favoured by an intellectual environment composed of

this dualism, which presented itself in rational as well as traditional forms. Induction had given the Ionians their new physical knowledge, and its practice gave the Hippocrateans their Medicine, a Medicine which was built both on empiricism and the careful observation of Nature. They accepted health as the norm; they collected all the facts they could respecting the departures from the norm of which they were the witnesses, and how these departures were caused, and why; and their science was fortified by the biological genius of Aristotle. Thus were laid the foundations of the science and art of Medicine to be found in Greek knowledge and practice and in the Greek method of approach.

Now it was perhaps inevitable that the growth and widening of knowledge in the Alexandrian School, supplanting as it soon did the first principles of Hippocrates, should lead to diverse doctrinal and static expressions of varying experience and differing abstract conceptions. Thus arose various schools, to which passing reference must be made. The followers of Asclepiades, the atomist, formulated a scheme of pathology dependent on molecules and pores, and of therapeusis based on systematic interference with disease as opposed to reliance on the healing power of Nature, and this doctrine was called *methodistic*. The medical men who followed the Stoic philosophers endeavoured to introduce a scheme of Medicine based upon the action of the vital air (Anaximenes, Empedocles), were much intrigued with personal hygiene, and described themselves as *pneumatists*. Some adhered strictly to the idea of the old four humours and became *humoralists*. Others called themselves *dogmatists*, attempting to prescribe what subjects and doctrines should, and what should not, be comprised in orthodox Medicine. Finally, there were the *empirics* and *eclectics*, who were pragmatists. From the point of view of the preventive aspects of Medicine these sects, though significant of the gradual evolution of medical thought, are relatively unimportant to us.

Greek Medicine—Ionian, Hippocratic, and Alexandrian —did not, and could not, in the circumstances remain

static, nor even purely Hippocratic. Alexandrian Medicine was, it is true, the composite amalgam of medical knowledge at the beginning of the Christian era, but in its distribution it became fissiparous and was in considerable degree broken up into component elements, partly due to its geographical dissemination in varying cultures, and partly due to its doctrinal sects and specialisms. These we cannot here pursue, for we must consider rather what happened to Greek Medicine as a whole when the zenith of the Alexandria-Greek School had declined after the arrival of the Romans. Its transmission was in four directions: (1) First it was carried to Rome; (2) next, in the form of Byzantine Medicine, it was carried by the Nestorians to Arabia, and thence by the Mohammedans to Egypt, North Africa, Spain, and Gaul; (3) somehow or other it was conveyed to Salerno; and (4) in the fifteenth century on the fall of Constantinople it was borne to Italy, and to western Europe by Linacre and his descendants. As I have said, the science of Rome was Greek in origin.

There were Greek physicians in Rome before the decline of the Alexandrian School and the subsequent larger migration to Rome. But we know little of them. In the first century A.D. Medicine among the upper classes in Rome had moved from folk-lore to a Greek Medicine coloured by Roman culture. Then came Asclepiades of Bithynia (A.D. 125), an ardent disciple of Erasistratus of Alexandria. He was an atomist, and brought methodism with him. He wrote much on health and disease and their interrelation, and is embalmed in Galen. He advocated hygiene by restoring the normal movements of the atoms of which the body consisted and by dietetics, and was the first Alexandrian to preach to Rome bodily health by means of regimen, fresh air, exercise, massage, baths, and sufficient hours of sleep for children. Celsus the scientific layman and Pliny the naturalist produced encyclopaedic books and Dioscorides an epoch-making book on botany; Rufus of Ephesus wrote on anatomy, and described bubonic plague and gout; and Soranus the obstetrician elaborated gynaecology.

Galen of Pergamum

All these were eclipsed by the mighty figure of Claudius Galen of Pergamum (130–201), who lived 600 years after Hippocrates. He was taught by his father, Nikon, an architect, physicist, and engineer, and trained in logic at Pergamum schools and subsequently at the University, which had been established by the Attalid kings and retained the Ionian philosophy and Platonism. At 18 he began to study Medicine at Smyrna and later at Corinth and Alexandria. After nine years absence he returned home to be physician to the gladiators, and in 161 he visited Rome, where he became physician to the Emperor Marcus Aurelius. His self-assurance and skill soon created a large practice among the upper classes, but his success led to jealousy and disfavour, and so in five years he left Rome to return home. But Marcus Aurelius recalled him, and during his second residence in Rome he turned to literary work and became commentator and recorder of Alexandrian Medicine. His works form perhaps half of the surviving Greek medical writings (some twenty-two volumes), covering every department of Medicine. He is Hippocratic, but added much, for he was a born experimenter, a successful practitioner, a pioneer anatomist, a physiologist who elucidated the correlation between structure and function, and a Stoic teleologist.

As a traveller in the Greek world, the Herodotus of Medicine, Galen brought the learning of Pergamum, Smyrna, Corinth, and Alexandria into Rome. It is both fortunate and unfortunate that Galen was a compiler and commentator in detail, without comparable successors to audit and check his record. But in the first century of our era he furnished a record of immense volume, much the grandest and most complete synthetic survey of Greek Medicine ever produced. His works fixed medical knowledge for 1,400 years, as all later writers accepted his word as authority. He was more definite and explicit, more systematic, than any other physician in the Roman world. It has been said that for Rome Galen was a popular and influential episode; for the

Middle Ages he was an epoch. After the death of Marcus Aurelius Galen was at Court under the Emperor Septimius Severus, and died in 201. His latest royal master died ten years later at York.

We know very little of Hippocrates and even Sydenham is rather a dim figure, but of Galen a fairly full biography can be written and his portrait is firm and clear. We know about his boyhood and his surroundings at Pergamum, Smyrna, Corinth, Alexandria, and Rome. He travelled in the Aegean, missionary journeys not dissimilar in locus to those of Paul of Tarsus, another great figure immediately before his time. They both understood the Greek world as it was absorbed by Rome—both were Greek-speaking Roman citizens, both came from Asia Minor writing letters of travel, both were missionaries of their respective Faiths which were struggling for life in an otherwise preoccupied world. Each found something akin in Stoicism and Neo-platonism, yet each had somewhere near his heart a burning desire to win for himself and persuade men to accept his own evangel. To Galen 'Nature does nothing in vain'; to him the universe is rational and purposive, utilitarian as well as cosmic. Both men came at last to join the ages as masters of human thought and of noble endeavour.

What Galen did for Greek Medicine was to collect its scattered elements and embody them, some critics would say embalm them, in permanent and comprehensive form. 'Galen divided medicine', wrote Sir Clifford Allbutt, 'into two equivalent parts—the remedial and the hygienic.' Like Herodotus he is an observant traveller, a witness of his times. But he is also an expert witness. He digests and assimilates all the medical knowledge of his day, adding his own rich and varied experience and learning, anatomical, physiological, and clinical. He brings pragmatism to the philosopher and rationalism to the empiric. In his catholicism he disregards the doctrines which he considers to be decadent and the sects which he holds to be redundant. His thoughts are not our thoughts, for he lived in a wholly different world more than seventeen hundred years ago, and yet some of his notes and letters, some of these

compendious volumes, seem very near to us, and for many centuries they constituted almost a medical Bible. It is true they enshrined some ill-fated errors (such as the interventricular perforation, and the existence of air in the ventricle) which exerted a wholly baneful influence for centuries. One of our eminent medical historians says that 'Galen adopts the Roman law-makers' habit of codifying and systematizing knowledge, sets the pace for the great medical encyclopaedias of the Byzantine, Arabian, and medieval periods, and through his mania for seeking the "why" rather than the "how" sterilizes the Medicine of the West for nearly 1,700 years.' Now whilst this is true in itself, we must not, at this distance of time, overlook the immense advantages which Galen provided. It is hardly his fault that he had no comparable successors who could criticize his work or bring it up to date. For its day and generation it is beyond all question the greatest compilation we have left to us of the state of the science and art of Medicine in the second century of our era.

Its interest to us in our study of Preventive Medicine is threefold. First, as far as our records go, Galen applied the experimental method to a greater number of medical problems than any other physician of his time. Indeed he became 'the greatest master of scientific method from the second century to Roger Bacon' (Allbutt). He found blood in the arteries and claimed that this blood carried air to the tissues; he held that there was a vital relation between the organism and its environment, and he believed firmly in the inherent healing powers of Nature. Secondly, Galen's preventive conceptions started always from the scratch-line of health as the norm. In *The Preservation of Health* he confirmed not only the hygienic way of life—diet, exercise, rest, fresh air, cleanliness—enunciated by his enlightened forerunners, but he claimed that in every case such a regimen must be prescribed or judged by its effect on the individual. 'Among the chief essentials—indeed the elementary basis as it were—of the whole subject of hygiene is the fact that there are among people a great many different constitutions,' and each must be dealt with individually. Lastly,

Galen was one of the first great epidemiologists. 'There are', he says, 'three causes of disease: the first resides in that which enters the body, the second in that which happens within it, and the third in what outwardly affects it.' In our modern terms there is, in his view, (*a*) an initiative, exciting cause, (*b*) an intrinsic temperamental or predisposing cause, and (*c*) an external environmental cause; and these are the points the epidemiologist must seek to differentiate. We must not attempt to build too firmly upon this rather elusive foundation, nor press the definition too far. Galen did not apparently appreciate any more than Hippocrates the idea of infection, and his passing reference to 'seeds of pestilence' is inconclusive. But he believed the principal external factor in the production of epidemic disease was the season and character of the atmosphere, and the second factor, by the operation of which some were attacked and some escaped, was temperament and habit of life. To us these seem to be elementary conceptions, but in the second century they went a long way to clarify the obscure, nebulous, and even magical explanations of the occurrence of disease, which belonged to an earlier age.

The Medical Services and Sanitation of Rome

Whatever may be said about Galen's specific contribution to Preventive Medicine, it is certain that Rome in his day and before his day had learned much Greek hygiene, had provided public medical services, and adopted public sanitation upon an enormous scale. To this we must now turn.

(1) Like many Greek cities since the fifth century Rome had *public medical officers* engaged in treatment of the poor, in epidemiological duties, in military service, in sanitation, and in town-planning and house-building.

We have all heard the romantic story of Democedes of Croton, as told by Herodotus, and how he was called in to treat Darius for a sprained foot, which turned out to be a dislocation, and of how subsequently he was consulted by Atossa, the daughter of Cyrus and wife of Darius, for an abscess on the breast, and what befell him in this case. Now

it happens that Democedes was a public medical officer to the State of Aegina, at a salary of £240, then to Athens itself at £400 a year, and subsequently to the famous isle of Samos at nearly £500 a year. 'It was in no small measure from his success' (as public medical officer), says Herodotus, 'that the Crotonists came to be reckoned such good physicians; for about this period (sixth century B.C.) the physicians of Crotona had the name of being the best, and those of Cyrene the second best, in all Greece.' Again, Diodorus tells us how, in some places, there was a law that certain persons should have a right to free treatment from a public medical officer. So it came about that in the fifth, and perhaps in the sixth, century B.C. public medical officers were appointed in the cities of Sicily and Magna Graecia. By the fourth century the public medical officer had become a common institution throughout Hellas, and we know that in many cities there was a special public tax for the payment of such officers. Plato tells us such officers were elected by a public assembly. We may assume that this public medical officer was what we should call a 'medical officer of health', for he had duties of association with the city architect and was concerned with water-supplies and drainage, and probably such an officer was partly concerned with the sanitary and hydraulic works in prehistoric Crete. Such medical officers existed in Rome in the reign of Julius Caesar, and at Marseilles in 30 B.C. The medical officer of health was not the only public medical officer, as there were in Greece medical officers of the public schools, of the gymnasia, of the gladiators, and of many guilds. There were also district medical officers, the army and navy medical officers, and medical assessors to the magistrates. Under the early Roman Empire a service of public medical officers (*archiatri*) was established by the State and in A.D. 160 in local cities and districts. In the Justinian Code (A.D. 533) it is enacted that a public medical officer 'shall choose rather to do honest service for the poorest than be disgracefully subservient to the rich', very sound advice to public officers permitted, as was the custom, to take fees from the wealthy. The Roman system of

medical organization is perhaps best seen in its evolution in the army.

(2) Still more in *the sphere of sanitation* Rome, in its World Empire, paid great attention to public water-supplies, house and land drainage (particularly drains of malaria-producing marsh-land), road-building, food control, domestic architecture, and the heating of houses and baths by hypocausts.

In a previous lecture I have referred to the evidence we have of the vast sanitary works and appliances constructed in Crete, Assyria, Babylon, and Phoenicia in almost prehistoric times, buildings comparable to the pyramids in conception. Yet it was in the Roman Empire that such works were brought to a hygienic and utilitarian purpose not previously reached. There were eleven aqueducts (312 B.C.–A.D. 226) bringing water to Rome, and ten of them had been constructed within 400 years preceding the advent of Galen. They were the glories and triumphs of Rome, and have been described by Sextus Julius Frontinus (A.D. 35–104), a Roman soldier and water-commissioner who, for two years, ruled in Britain as Governor. These aqueducts were partly constructed on arches supporting the water conduit, and partly underground. They varied in length from 11 to 65 miles, and have been estimated to deliver a supply of many million gallons of water daily (providing upwards of 30 gallons per person). The aqueduct was a method commonly used all over the Empire and no fewer than 200 have been recorded, the most celebrated being the aqueducts of Rome itself, the Pont du Gard at Nîmes, and the Segovia at Tarragona. It should be added that the Romans also practised the domestic filtration of water through porous stone or sand filters. The provision of Roman water-supplies set an example to the world, all too often neglected in after times. Indeed it is impressive to reflect upon the fact that with the exception of Paris (which formerly had aqueducts) and London's New River of 1613, it was only in the nineteenth century that Western civilization followed the example of Rome on any considerable scale.

The drainage of towns in the Roman world naturally developed more or less concurrently with the public water-supplies, and had similar Greek, Babylonian, and Etruscan origins. The construction of the Cloaca Maxima in Rome was begun by Tarquinius Priscus (616–578 B.C.) first as an outflow for ground water and later for sewage. Pliny provides in Book XXXVI a quaint account of its construction by slaves and the penalties as well as physical difficulties they encountered. The cloaca formed the basis of the house and city drainage, and set an example for the Empire generally.

(3) Next we must consider *housing*. The Assyro-Babylonian house was evolved from without inwards with an eye to defence from nomads and wild beasts. The Western house evolved from within outwards. No one has told their story better than Dr. Fielding Garrison of Washington, and I will give you a quotation from his papers:

'The underground caves of prehistoric man, the serried rows of ridge-ventilated Egyptian houses, the brazier fires of Greek palaces, the Roman hypocausts, the igloo of Lap and Esquimaux, the smelly, sod-built hovels of the primitive Scotch, the Irish cabins, the Scandinavian and English cottages, the huddled walled towns of the Middle Ages, the Norman castle with its jealous winding stairs, the sensible, high-vaulted hearth of the Persians, the highly ornate fireplaces of the French Renaissance, illustrate the enormous ingenuity expended upon heating and ventilation. The open fireplace is perhaps the most picturesque detail in the history of hygiene. The heat of an open fire is radiated heat and in the most primitive habitation, good air circulation was secured by crevices in the loose construction. Such a house was, in the phrase of Terence, *plenus rimarum*, full of chinks. The heat of a stove at ordinary temperature is convected heat in process of becoming radiant. In such interiors, glass window-panes, where existent, make for draughts in winter time, in accordance with Carnot's principle and the discovery of Pettenkofer, that air can pass even through the thickest masonry. The evolution of the stove, furnace, boiler, and radiator coil from the open fireplace is a complex history.

'As fire from the old Greek tripod or brazier sometimes killed by monoxide poisoning, the Romans hit upon the device of a ventilated, extramural, underground heating-plant (*fornax*, furnace) of log embers, leading into a hollow space underneath the floor of the house

(*hypocaustum*) which was supported by uprights (*suspensurae*) and connected with the walls in all four corners by hollow tiles, communicating with similar spaces in the adjacent rooms and upper stories and eventually discharging smoke and gases by an outside vent. This invention, attributed to Sergius Orata (100 B.C.), is mentioned by the younger Pliny (*Ep.* 1, 2, No. 17) and Seneca (who also mentions window-panes), and is described at full length in the *De Architectura* of Vitruvius (*c.* 50 B.C.), and while first applied to public bath houses, became common in the dwellings of the wealthy about A.D. 10. The oldest specimen excavated was found in the *caldarium* (sweating room) of the old and new *thermae* at Pompeii. Other hypocausts were discovered in the baths of Caracalla, in a villa at Herculaneum (Winckelmann), in the Emperor Hadrian's palace at Treves and in the thermae of St. Barbara in the same city (*c.* A.D. 286–388). Actual smoke pipes are found in the remains of the Saalburg. Hypocaustal heating thus penetrated to the northern marches (Germany) and became common in Britain, as evidenced by Roman remains at Dover, Chester, Cirencester, Lincoln, and other towns, but died out in Italy during the decline of Roman power.'

Many of us must have had the opportunity of checking a number of these interesting points on the spot, and we shall appreciate their significance. The characteristics of the Roman house itself may be well observed at Pompeii, where different types and sizes of house may be seen dating from the first century A.D.—the frigidarium, tepidarium, caldarium, and the men's and women's baths, &c.

(4) *Malaria* was known in Sicily and the peninsula as early as 500 B.C. but did not establish itself in Latium until 400 B.C. (after it had declined in Greece). By the end of the Republic marsh lands in south Italy and the Roman campagna had become infected, and here and at Ravenna malaria still flourishes. Varro (201–116 B.C.) and Columella (first century A.D.) knew that marsh land bred 'invisible animals' which fly and sting, 'whereby hidden diseases are contracted'. Hence in due course arose the practice of systematic drainage of such infected marshes—a very early example of the adoption of modern sanitary measures of Preventive Medicine.

(5) As a fifth example of the Roman application of the principles of hygiene and Preventive Medicine I may cite

the development of *hospitals*. It is in some ways their greatest contribution, and arose, like their medical organization, from their military system. The Greeks had introduced surgeries and clinics (*iatreia*) both for private practitioners and for their health temples. A temple of Aesculapius had been established on an island in the Tiber in 291 B.C. (reconstructed in the ninth century), with serpent and staff as symbols, for the treatment of slaves and later on for the sick poor. In the first century there were in Rome and in the Empire various clinics (*iatreia*), infirmaries (*valetudinaria*), temples of Aesculapius, and hospitals. The hospitals were sometimes military foundations, but were developed as civil institutions under Augustus and remained until they were closed by the edict of Constantine in A.D. 335. They flourished for a period of 300 years and were followed by a millennium of neglect. The great Roman hospital at Novaesium on the Rhine, built by Tiberius early in the first century, represents the best features of a Roman hospital. It was built on the corridor system with wards opening therefrom, many of them small. There were 38 sick wards and accommodation for 200 patients. At Carnuntum on the Danube another contemporary and similar hospital existed. Much attention was paid to fresh air, water-supply, and drainage.

These medical institutions (*iatreia*, *valetudinaria*, Aesculapian temples, hospitals), with the ordinary pilgrim rest-house on the roadside, were the beginnings of our modern hospital system, which may be said to have recommenced in the eighth century and which received pioneering support in the thirteenth century from Innocent III, who not only founded the great model of the Santo Spirito in Rome but also inspired the founders of many of the great hospitals of Europe. They were of course remedial in intent, but now we are learning that effective cure is preventive, not in the form of therapeutic technique but in result.

The Transmission and Transmutation of Greek Medicine

After the decline of the western Roman Empire the Greek tradition of Medicine passed, though in some decadence, to the Byzantine Empire, and first to Byzantium itself. Its

first four leaders were Oribasius of Pergamum (326–403), who produced an encyclopaedic compilation of seventy volumes; Aetius of Amida, physician to Justinian, who wrote on surgery and obstetrics, and described epidemic diphtheria, goitre, and rabies; Alexander of Tralles (525–605), who wrote on dysentery and cholera; and Paul of Aegina, the surgeon. But Oriental magic, superstition, and demonology remained, and the early bloom on Hippocratic Medicine had vanished. There also remained the authority of Galen, and the public health administration and sanitation of Rome, its housing and its hospitals. How did all this affect Europe?

Some time after the beginning of the Byzantine Empire Nestorius of Antioch was Patriarch of Constantinople (428). He supported the view that Mary was the Mother of Christ and not of God, and for this heresy he was banished by the Council of Ephesus at the instigation of Cyril of Alexandria (431). For several years he retired to a monastery at Constantinople, but was eventually condemned to exile in Arabia, and died in Egypt. He became, however, the founder of the Nestorian Church, which played such a strange part in the propagation of Greek Medicine. For on their expulsion from Byzantium the Nestorians moved eastward into Syria, carrying with them many manuscripts, a high scholastic tradition, and much individual medical skill and experience.

We must now follow their trail, step by step.

(i) Already under the Seleucids Syria had, by Alexandrian influence, become more deeply Hellenic, and at *Antioch*, *Beyrut*, *Nisibis*, and *Edessa* Greek medical principles were continued and practised, derived partly from the Byzantine Nestorians, and partly from Alexandria. The 'Syriac Book of Medicine' was a Hippocratic book written by a Nestorian physician educated in Alexandria, and the first section advocates the hygiene and sanitation of Diocles. In this and other ways, Syrian Hellenism thus became the vehicle of Greek Medicine to Mesopotamia.

(ii) Edessa possessed two large hospitals conducted by the Nestorians, and when in 489 religious persecution drove

them farther East they settled at Gondisapor in Persia, where again they Hellenized the medical practice. The closure of the medical schools of Athens by Justinian brought increased Greek support to Gondisapor, the birthplace of Arabian Medicine, and to Bagdad, which became an important centre of Persian and Vedic Medicine, Syrian Medicine from Alexandria, and Nestorian Greek Medicine. Thus at the time of the birth of Mahomet in 571 Gondisapor and Bagdad were the chief centres of medical learning in the East.

(iii) The Arabian period dates from 622, the year of the flight of Mahomet, and the beginning of the amazing conquests of the Arabs, one of the most extraordinary invasions in the history of man. They covered Persia, Arabia, and Syria; they conquered Egypt in 640; they passed along the north coast of Africa, invading Kairawan and Timgad and probably Sicily also, and they reached Tarif in the south of Spain by 710; all Spain was theirs by 724; and by 732 they had crossed the Pyrenees and reached the gates of Tours. Here they were defeated, as we shall remember, by Charles Martel, who drove them back into Spain, where they established a Western Caliphate. From 755 to 1236 this Western Caliphate of Mohammedanism had its headquarters at Cordova, the Eastern Caliphate remaining with its capital at Bagdad.

(iv) After the Saracen armies came the Arabian learning, including the Arabic translations and transmutations of Nestorian Medicine and the works of Aristotle picked up during their passage through Egypt.

(v) Medical schools and hospitals were established in Spain at Cordova, Seville, Granada, and Toledo, and possibly at Magnelone (or Montpellier) in 738. Cordova (750–850) became an immense city of a million people, 300 mosques, 200,000 houses, and a vast library. The famous Arabian physicians and translators, Albucasis, Averroes, and Avenzoar worked there, and they were subsequently followed by many European scholars. It became the chief European medical school of training. *Albucasis* (936) was the most original of the Western Caliphate

surgeons, and wrote his general encyclopaedia of Medicine which circulated through Europe for 400 years. *Averroes* was a commentator on metaphysics. *Maimonides* wrote his Book of Counsel on dietetics, hygiene, sanitation, and poisons. *Avenzoar* was a clinician, and dealt with pharmacology and parasitology. Cordova became a centre of translation and circulation of the Arabian interpretations of Greek Medicine and thus contributed to the spread of Arabian Medicine in Europe.

(vi) The Eastern Caliphate at Bagdad and Gondisapor, earlier in foundation, carried on its clinical work, a mixture of Greek Medicine and the medical art of Arabia, Persia, and the Far East. *Johannitius* (809–73), a Nestorian, travelled in Greece, and wrote Arabic translations of Hippocrates, Galen, and Aristotle; *Rhazes* (841–923), the most original of the Arab writers, had been trained as a student of philosophy, and at the age of 30 went to study Medicine at Bagdad. He became physician to the hospital about 902, had a fashionable practice, and travelled widely in Persia (until overtaken by ophthalmic cataract and blindness). Rhazes was learned in Hippocrates and Galen, and the ablest physician in the East of whom we have record. He used drugs sparingly, but strongly advocated hygiene and dietetics, and wrote an encyclopaedia of Medicine (25 volumes), longer even than Avicenna's Canon. It was Rhazes who described small-pox and measles, and their differentiation. *Avicenna* (980–1037) was the exponent of metaphysics and folk-lore. He adopted the Hippocratic writings as modified by Aristotle, and compiled the classical Arabian Canon, which remained all too long the standard of authority in Arabian Medicine.

Such was the entry of Arabian (Greek) Medicine to Europe. Without overlooking the sweeping conquests of Alexander the Great, Sir William Osler used to say that no such phenomenal social change had ever been made within so short a space of time as that which the Arabs achieved between 632 and 732 when they altered the map of Asia and Europe. Within a century the crescent swept from Arabia and Persia through the Eastern Empire, over Egypt (destroying for the third time the great Alexandrian library),

over North Africa, over Spain, over half France. They meant to conquer Christendom, and were only stopped from so doing by Charles Martel at Tours. They were driven back into Spain, and there they settled for 800 years. But it was not all to the bad. This is what Leclerc says:

'The world has but once witnessed so marvellous a spectacle as that presented by the Arabs in the ninth century. This pastoral people, whose fanaticism had suddenly made them masters of one half of the world, having once founded their Empire, immediately set themselves to acquire that knowledge of the sciences which alone was lacking to their greatness. Of all the invaders who competed for the last remains of the Roman Empire they alone pursued such studies; while the Germanic hordes, glorying in their brutality and ignorance, took a thousand years to re-unite the broken chain of tradition, the Arabs accomplished this in less than a century. They provoked the competition of the conquered Christians—a healthy competition which secured the harmony of the races. . . .

Before the ninth century had run to its close, the Arabs were in possession of all the science of the Greeks; they had produced from their own ranks students of the first order, and had raised among their initiators men who, without them, would have been groping in the dark; and they showed from this time an aptitude for the exact sciences, which was lacking in their instructors, whom they henceforward surpassed.'

What did the Arabs do?

Now what was it exactly that the Arabs did for European Medicine? It is a long, complex, and chequered story. They did some things which were disastrous. For instance, they destroyed the remains of the great medical library at Alexandria and they introduced into Europe a copyist and static Medicine, derived mostly, though not wholly, from translations. Yet they did in fact bring Islam and Occident together, supplying new and strange impulses richly energizing to Western science; they did bring Greek Medicine and Aristotle to Europe, and though not of the purest type, this was a supreme thing to achieve. It is their primary service to have brought the great translations of Greek, Syriac, and Ptolemaic Medicine, in Arab dress, into Europe for its retranslation into Latin. This forced Europe to join

Philosophy and Medicine and make the conjoint amalgam progressive. It led, in part, to a Scholastic Medicine and to placing European Medicine under the thraldom of Galen and the schoolmen. But it did result in reawakening Western Medicine to renounce its sequestered existence and accept the inspiration of the Greek spirit.

Their secondary service was perhaps subsidiary or ancillary, but none the less substantial. I think we must place the establishment of medical study and medical schools and examinations next to the new translations. The Arabs confirmed in Europe the necessity of a definite standard of medical studies, with an examination system to prove capacity for medical practice. The fact that examinations have now unfortunately tended to become a thraldom, tended to lead and standardize study instead of following, is not good ground to condemn them as such. For adequate examination has a twofold value beyond being a test; it raises the worth and authority not only of a registrable qualification but of the whole profession of Medicine as a part of true learning and not a menial avocation; and it brings abstract learning into touch with hospital and clinical work. The Arabs were the first to use their hospitals for teaching purposes, and what this has done for Western Medicine is beyond compute. Beautiful as are the palaces and gardens of Cordova, her claims to admiration in higher matters are not less strong. The mind was as lovely as the body. Another medical school, as we shall see in a few minutes, surpassed her in seminal power, but in her great days she became the centre of European culture and drew students of all nations to herself. 'Every branch of science was seriously studied there, and Medicine received more and greater additions by the discoveries of the doctors and surgeons of Andalusia than it had gained during all the centuries that had elapsed since Galen.' And Montpellier became her adopted daughter.

Next, the Arabs developed certain aspects of medical study which in time became integral to the science and art of Medicine; for example, chemistry and pharmacy, materia medica and pharmacology, optics and mathematics, trace

their origin as constituent parts of medical study back to the Arabs. They not only introduced apothecary shops and many drugs, but also laboratories, and out of that germ has grown much, and there is still much more to come.

Fourthly, the Arabs brought to Europe a certain clinical acumen which renewed in her the inquiring mind, which though it would learn from Galenism would not be bound by it. Rhazes had diagnosed small-pox and differentiated it from measles, and had been in the Eastern Caliphate the exponent of personal hygiene, and health as the norm. He was more Greek in practice and inspiration than most of his contemporaries. This spirit also imbued the Western Caliphate. It was less great in its currency than in its progeny, for from it was to spring wider views of the clinical aspects of Preventive Medicine.

We have now followed the transmission of Greek Medicine from Alexandria to Rome, and to Europe through the Arabian invasion of Spain. There remain two other channels, a narrow one through Salerno, and the broad influx of the Renaissance in the fifteenth century. For the student of Preventive Medicine these are the two most direct channels.

Salerno

As the traveller comes through a defile of the Sorrento mountains, thirty miles south of Naples, he catches sight of the Gulf of Salerno. Before him lies the Tyrrhenian Sea with Monte Stella and Cape Licosa as its southern boundary, and with Monte S. Angelo above Amalfi on the north. The mountains come steeply down to the sea, with the exception of the long marshy plain of Paestum, where 500 years before Christ stood the flourishing Greek city of Poseidonia, now vanished. Nestling below on the shore stand the white walls of Salerno, its foot almost in the blue waters and its steep streets protected by the spurs of Mount Alburno. This sacred spot was the first home of a Greek School of Medicine in the West.

Into that bay there came in ancient days argosies from the Levant, from the islands of the Aegean, and from

Tunisia, bearing cargoes of merchandise and traders, of manuscripts and pilgrims, and in later days of friars and crusaders. Across those same Calabrian hills farther to the south tramped the Greeks from Magna Graecia, the descendants of Alcmaeon and Pythagoras. From Petrarch to Longfellow we have the songs of praise bestowed upon this *fons medicinae*, this celestial *civitas Hippocratica*.

> Everlasting praise is the meed of distant Salerno
> Thither from every land come the sick in throngs unnumbered.

Yet is there mystery and obscurity about the long past of Salerno. Such a fertile and prosperous colony of mankind was vulnerable, and for many centuries the envy of less happy lands. The Ionian Greeks came to Calabria and Salerno in the sixth century B.C. in the age of their expansion over the Mediterranean basin, and as we know established at Sybaris and Crotona their schools of Pythagorean philosophy. They formed colonies at Naxos and Catania at the foot of the long slopes of Etna, they came also to Poseidonia where their temples now remain 'in so great majesty'. They brought with them Greek tradition, custom, and love of learning. Three hundred years later came the Romans down the steep gorges of the Sorrento mountains, and nine hundred years after the Romans there came the Saracens across the sea. From the seventh century A.D. Sicily and southern Italy were the continual prey of Arab invaders, and they were followed by the Normans. All this is important for us to remember, for these conquests of Italy left their mark upon Salerno, after Poseidonia had disappeared.

Long has raged the controversy as to the foundation of this ancient European Medical School. Yet in fact it was never 'founded', neither by Greeks nor Jews, neither by monks nor philosophers. It grew. Nor was it a university in our sense of the term; it was first a port of trade, then a place of sojourn for pilgrims, crusaders, and invalids; and thus, at latest by the ninth century, a hospital centre, which by the tenth century was far famed for the skill of its physicians. By the eleventh century, strange as it sounds, Salerno was the most celebrated medical school in Europe.

What had made it so? That has been a puzzle to all historians. It is clear that it had become a port of call for merchandise and travellers from the East. It had also become a spa. Its beautiful situation, its protection from cold north winds, its sunny and mild climate, and its accessibility had made it an invalid centre, with a mixed but harmonious society of lay, clerical, and medical healers. Into this community there came Greek Medicine and Constantine the African. It had been Greek in colonization from Poseidonia, and the Greek language had survived within its walls. Greek doctors came from Magna Graecia, from Byzantium, and from the Ionian Sea. It was a Tyrrhenian Cos, with Latin translations of Hippocrates and Galen derived from Rome, emulating the example of the Coan physicians, a diminutive *civitas Hippocratica* in practice if not in learning. Medical scholarship, literary erudition, critical and pioneering inquiry—these things were not sought after in the early times of Salerno.

This was the place to which Constantine the African came somewhere about 1070, and according to Sudhoff he brought to it the Arabian interpretation of Greek Medicine and possibly translations of some of the works of Hippocrates. He is supposed to have been born in the first quarter of the eleventh century in Carthage, and after some eastern travel and much study set out from the North African coast to sojourn at Salerno, before finding a last home in the monastic seclusion of Monte Cassino under the Abbot Desiderius. Many of the translations from Arabic into Latin attributed to him were probably not his own work, but a 'Pantegni' and an 'Ars Parva', with a 'Viaticus' (for travellers), and some Hippocratic-like aphorisms were held to be his own. His works attained an almost unparalleled circulation and acceptance. In any case it seems clear that his translations from Ali Abbas and Ibn al Dschazzar were more closely related to pure Greek Medicine than the Canon of Avicenna, which was overloaded with Arabism and never acceptable to the Salernitans. Hence Constantine became the introducer to western Europe of purer Greek writings than any before the Toledo or Italian

translations. The Salernitans thus became the isolated exponents of a Greek Medicine interfused with their own sensible observations and unbiased representation of morbid phenomena as they saw them, and with dietetics and hygiene as practical remedy rather than the doctrinaire medicaments of the Arabs.

This isolation in a place and a time when the Saracens were invaders is significant and characteristic. For Sicily and southern Italy were widely visited by the Arabs coming from North Africa in their journey towards Spain. They were in Sicily in 665, and conquered it 200 years later, and they certainly reached Salerno between the eighth and ninth centuries. Yet when Avicenna's Canon was introduced to the town a century after Constantine it gained no adherence, for the best of Islamic Medicine had arrived before it. 'The Salernitan masters were the first in the Christian West', says Neuburger, 'to establish an independent nursery of Medicine, serving the interest of science only, where all branches alike found recognition; they strove by practical instruction and didactic literature to make their knowledge and capacity common property; they ennobled the healer's art.'

It is when we come to analyse Salernitan Medicine that we find its secret. Here was an isolated and independent group of physicians, a factor in the academic polity of the early middle ages, which had little or no influence on the development of collegiate institutions, and yet cultivated and nurtured a small Medical School of free Greek thought. Let us make an inventory of its goods:

(*a*) Its *anatomy* was practical and not book-learning, and was learned by direct and technical dissection of animals, chiefly the pig; its *physiology* was Galenic; its *pathology* was humoral, but distinguished by plain, lifelike descriptions of disease as observed; its *materia medica* was comprehended in an Antidotarium of Nicholas and the book of simples of the Platerius family; its *diagnosis* was largely dependent on pulse, fever-lore, and uroscopy; its *therapeutics* were personal hygiene and dietetics, and it eschewed astrology and magic.

(*b*) Its surgery was made famous all through Europe by the famous Roger Frugardi, who wrote his great book *Practica Chirurgiae* on his experience with wounded crusaders, and in the *Trotula* (which may have been a generic term for womankind) gynaecology also had wide circulation.

(*c*) Hygiene was one of the chief subjects taught, and the *Regimen sanitatis Salernitanum* (probably twelfth century) became world-renowned as a tract on Preventive Medicine —the value of fresh air, cleanliness, rational eating and moderate drinking. In course of time innumerable interpolations were added, and the book ran into several hundred editions. Arnold of Villanova, one of the pioneers of hygiene in the thirteenth century, became one of its editors.

(*d*) It was at Salerno, in 1140, under Roger of Sicily, that the first edict was enacted penalizing those who undertook medical practice without previously having their capacity proved and obtaining the permission of the State. It was Frederick II of Sicily who in 1231 first granted a royal licence to practise Medicine.

We cannot now, eight hundred or a thousand years later, assess all that Salerno did for European Medicine, nor its precise Greek origins in chronological order. But of some things we may be sure. Salerno was historically the first medical School and seed-plant of Greek Medicine in Europe. It was small in compass and to be gauged by small measures. We know also that it was partly a lay school and wholly a lay foundation, specializing not in book-learning but in practical anatomy, practical surgery, the elements of natural diagnosis, and in diseases of women and children. It possessed 'a great experience of the soul of Nature', and went to Nature for its learning. Its zenith was in the time of the Crusades, from 1095 to 1224, when the University of Naples was established, and it remained throughout that period a free and independent medical centre, sane and untrammelled, a circumstance unknown elsewhere during the all-pervading Arabic infiltration. We know, too, that it exerted a strange but compelling charm on the Italian universities of the Renaissance, and thus on

all Europe. It had, moreover, two enduring characteristics, it was the medical school which first laid emphasis on Hygiene and Preventive Medicine, and it was the origin of the first regulations requiring qualification and licence for medical practice.

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V

THE MIDDLE AGES AND THE BLACK DEATH

Synopsis of Lecture V

The advance of Preventive Medicine by social attempts at defence.
The devastation of disease in the Middle Ages resulting in shortened life and static populations.
Social life in the Middle Ages: the feudal system, church, monastery, manor, guild. A growing social life.

The famine pestilences from the seventh to fourteenth centuries. Creighton's English list typical of Europe. (Gregory of Tours, Bishop Isidore of Seville, Anglo-Saxon Chronicles, Bede, Leechdoms, &c.)
Ergotism, pellagra, deficiency diseases. Inadequacy of food and agricultural provision.
Compare position in India in nineteenth century.

Leprosy in Europe and Britain: its nature and wide prevalence; the social ostracism of the leper. Efforts of church and monastery; ecclesiastical ordinances; laws against lepers. Leper houses and hospitals, relief and segregation rather than strict isolation. Absence of effective treatment, yet definite decline by fourteenth century. Why?

Plague in the West from the age of Justinian (542) to the Black Death of 1665. The outbreaks in Britain in 1348 and 1665. Causes and predisposing conditions. Mortality. Social and economic effects of disease, and its influence upon the destiny of nations. Its control necessary to national survival.

How England learned to control epidemic disease. The new lesson of the relation of social conditions, invention, and political emancipation to disease. Means of prevention, first beginnings of
(*a*) popular understanding of infection, contagion, transmission, and susceptibility;
(*b*) communal interest in disease; need for intervention of State;
(*c*) public control by ordinance and sanitary law;
(*d*) notification, isolation, and disinfection;
(*e*) quarantine and international co-operation.

V

THE MIDDLE AGES AND THE BLACK DEATH

From the end of the Western Roman Empire and the fall of Rome in the fifth century of our own era for the immense period of a thousand years there was in the history of Medicine nothing comparable to the Greek period. As we have seen there was wide transmission, with some transmutation, of Oriental knowledge, and here and there a beacon light shone brightly, guiding the lonely pioneers and heralding the new dawn which was to come at the Renaissance. From the fifth to the fifteenth century it was indeed a dark age.

Nevertheless Preventive and Conservative Medicine was not dead. It survived not in new knowledge of the medical art, still less in medical science, but in *social defences*. The people of England as of Europe were slowly and almost unconsciously feeling their way in the dark towards an organization of human society. They were troubled indirectly with incursions and invasions, with wars and rumours of war, with the Crusades, with quarrels between popes and kings; but meanwhile influences were abroad making for a new kind of order. The laws of Justinian which left so great a mark on Rome were followed by Charlemagne in Europe and Alfred the Great in England. The Benedictine Order preceded the Cistercian, and both Benedict and Bernard of Clairvaux began to leaven Europe as the coming of Christianity leavened England. Above all, feudalism dominated the Western world. It did not come at once, but its insidious growth and expansion profoundly changed the life of the people, and when we reflect on their survival and their inner and domestic life and health we must not be misled by outward and dramatic events to overlook the day-by-day influences which intimately affected them.

The Manor, the Monastery, and the Guild

In the Middle Ages the feudal system in England found expression in a form of autocratic governance as to land and labour which was represented in the manor, the

monastery, and the guild, and it was through these agencies that the English people learned how to control disease. The one all-pervading necessity was a food-supply. The population was agricultural and scattered on the land, and any degree of density which it had was purely local.

The England of Domesday Book, the first systematic survey (1086), contained about two million people, which doubled in three hundred years. Their most acute problem was to win from an uncultivated soil the means of subsistence. Above them was the feudal chief of each settlement, *the Lord of the Manor*. The people as a whole were not free men but bondsmen, serfs, villeins. They could not leave their holdings or go where they willed, their daughters could not marry outside the manor to which they belonged, their sons had no opportunity of bettering themselves outside its sphere, by his rights the lord was their judge as well as their employer, and the village officers were his officers, and the court of summary jurisdiction was his court. It was a self-composed and self-sufficient colony, providing its own subsistence and defence, making its own trading unit and its own ordinations of religion. There was, of course, some communality in these things and there was interchange between manors and districts, but the mass of the people were bound to their manor and labour was exacted from them. They had their plot to till in the open field system. They had to come with their own plough and cattle, and plough, harrow, sow, reap, and carry their crop. Their day's work was prescribed and their domestic life controlled. The customary law was administered through the manor court, and the manorial rule epitomized the early English State. It was a system of feudalized agricultural unit, the principal factor in medieval life, the controller of the chief industry, the basis of social development, the foundation of communal life and of local government.

From before the Conquest to their suppression by Henry VIII the *monasteries* exerted a less direct but scarcely a less powerful influence than the manors upon the mass of the people. They stood it is true, like the Church, for 'otherworldliness', for seclusion, for institutional religion, 'for

poverty, obedience, and chastity'. But their institution and their routine ordinations and compulsions proved a vast network of direct and indirect influence upon the manner of life and conduct of the people. They taught cleanliness in an unclean age, the elements of hygiene in a time of no hygiene; they practised organized relief of the poor when there was no Poor Law; they introduced books and libraries, education and schools; they became the chroniclers and recorders of their day. Each monastery had an 'infirmary' for the sick and senile—our first hospitals—adequate dormitories, sanitary offices, lavatories, a refectory, a library, a cloister, a guest-house—all innovations in the social life of early England. Their agriculture and estate management were the best of their day—sheep-farming, wool-production, house sanitation and land drainage, clearings, fruit-growing, road-making, bridges. They even established in organized form the elements of domestic Medicine, for they systematically practised blood-letting, cultivated physic gardens, and served the local district as apothecaries.

Cardinal Gasquet finds in the monastic rolls not only a picture of village life in the Middle Ages and the beginnings of our own customs, as I have just said, but an early form of the things we still seek.

Many of the points that in these days advanced politicians would desire to see introduced into the village communities of modern England in the way of improved sanitary and social conditions, and to relieve the deadly dullness of country life, were seen in full working order in Durham and Cumberland in pre-Reformation days. Local provisions for public health and general convenience are evidenced by the watchful vigilance of the village officials over the water-supplies, to prevent the fouling of useful streams, as to common places for washing clothes, and the regular times for emptying and cleansing ponds and mill dams. Labour, too, was lightened by co-operation on an extensive scale. Still more could be said for the health services of the Friars who followed the monasteries early in the thirteenth century.

For three hundred years the manor and the monastery

were the two dominant institutions which directly and indirectly governed the life of the English labourer. In the eleventh century they were followed by the *Guilds*—the religious, merchant, and craft guilds. All three of them arose as a natural manifestation of the association spirit engaged in defence. The religious guilds existed before the Conquest for mutual aid in old age, sickness, and poverty. The merchant guilds of the eleventh century at Cambridge, Abbotsbury, and Exeter possessed the oldest ordinances extant in Europe. Such guilds became numerous in small boroughs after the Conquest. Their function was to regulate the monopoly of their trade and protect it against 'foreigners' and non-guildsmen. They remained separate from the township of the Middle Ages, but eventually became a department of the borough administration and exerted a direct influence on the economic and municipal life. The craft guild of artisans was subsidiary at first to the merchant guild, though subsequently it became predominant. It contained masters, journeymen, and apprentices, and its chief object was to bind artisans together to secure good workmanship and protect the interest of the craftsman—to regulate hours of labour, provide for apprenticeship and training, protect processes, and control wages and prices. Though having at first no direct effect on the municipality, the craft guild was the principal medium for admission to citizenship. The benefits of the guild included a primitive form of insurance in sickness and for burial, social and educational advantages, and aid in the settlement of differences in the guild courts.

A growing Social Life

Out of this amalgam of social life—the manor, the monastery, and the guild—grew up the England of the Middle Ages. From it were to spring the elements which constituted the idea and practice of British citizenship, a national tradition, public spirit and public service, self-government. Recent historical research has revealed how profound and far-reaching have been the issues of this development. These institutions became the instruments

of land tenure, of tenant right and duty, of customary law. They introduced an agricultural and industrial system, with its wage standards, its obligations of apprenticeship and employment, its organization and protection. Still more remarkable was the part they played eventually in the rise of the middle classes, and *collectivism and the principles and methods of local government*. Out of them were to come new forms of civic co-operation, the Poor Law, the municipality, a public health service, and even a health insurance system —all four of them so unlike these mediaeval institutions and yet tracing their ancestry back to them.

There were four circumstances which changed the face of the Middle Ages. The sense of mutual aid engendered by the institutions to which we have referred led to unequal distribution of population, bringing people together in groups, in communal association, in townships. Joint co-operation in obtaining and ensuring a food-supply led to an increase both of population and of inter-communication, not only within the compass of particular nations, but between one country and the other, and this led in its turn to density of population in favourable areas. It led also indirectly to a closer and more fierce competition between nations. At the same time, these and other developments of a progressive civilization suffered two scourges, namely, famine and disease. So it came about that the social life of the Middle Ages all through the West was affected (*a*) by unequal density of population, (*b*) by unsettlement, conflict, and war due to social conditions, (*c*) by famine, and (*d*) by pestilence. The history books of a former day record in much detail the more outstanding and arresting of the events which concern war, but they pass over with comparatively scanty reference the changes in population and their causes, the struggle of the mass of the people to obtain food, and the profound effect of widespread disease. Yet the pestilences of the ancient world, the plague of the Antonines and of the age of Justinian, the Black Death, the epidemics of the seventeenth and eighteenth centuries, the disease which has followed armies from the Thirty Years' War to Napoleon and our own times, the pandemics of

influenza—these have exerted an effect upon the history of mankind on the whole more powerful, fateful, and enduring than any other single factor. As disease changes or terminates the life of the individual, so also it alters the course of human history.

Famine Pestilence

In his classic *History of Epidemics in Britain* the late Dr. Charles Creighton collected records of some forty or fifty famine pestilences in Britain from the end of the seventh century A.D. to the beginning of the fourteenth century. In those six or seven centuries there were no doubt long periods without anything which could be described as pestilence, as among individuals there was rude and robust health and physique. Nor have we anything substantial or reliable in the way of medical knowledge of such disease as was prevalent. The evidence is derived from the Anglo-Saxon chronicles, Bede's ecclesiastical history, leechdoms, and similar non-medical records. But it seems clear that famine pestilence was as characteristic of England as St. Anthony's fire (ergotism) was of France and lepra of Normandy. No doubt diagnosis was uncertain and indifferent, but we know that famine pestilence existed and something of its incidence and causation. Insufficient land was cultivated, the produce itself was poor and not seldom unwholesome or affected with parasites, and the crops were irregular. There were many bad harvests and the intercommunication was unsatisfactory. Three greater famines occurred: in 1194–6 in the reign of Richard I, in 1257–9 in the time of Henry III, and in 1315–16 at the end of the Scottish War, recorded respectively by William of Neuborough, Matthew Paris of St. Albans, a good guide, and John Trokelowe, also of St. Albans. In the thirteenth century crops were becoming more certain and prices were steadier. England was beginning to emerge from a pastoral stage.

Alongside agricultural uncertainty went a low standard of physique. 'Cancers', consumption, scrofula, dysentery, fevers, gout and stone abound, also the 'falling sickness',

St. Vitus's dance, palsies, jaundice, dropsies and fluxes, quinsies, boils and carbuncles, agues and bronchitis. Hysteria and maladies peculiar to women were common and we hear of 'pestis gutturosa', a putrid sore throat. Children were difficult to rear, and though we have no statistics it is probable that child mortality was high. Ergotism, from poisonous rye, though common in France was almost unknown in England, an immunity due to the non-consumption of rye. 'A liking for the best of food', says Creighton, 'and plenty of it when it was to be had, has clearly been an English trait from the earliest times.' Pellagra, frequent in north Italy and due to damaged or spoiled maize, was also uncommon in England.

The disappearance of famine pestilence soon after the end of the thirteenth century was due to sensible methods of prevention. Agriculture was extended and improved, irrigation was used, there was better communication for the carriage of grain from district to district in accordance with needs, and a wider distribution of palliatives through church and guild, manor and monastery, one of the earliest applications of religious opinion and compassion. It is interesting to recall that it was in the thirteenth century that grain was first imported into England from Holland and Germany, the beginning of a method of preventing famine in this country which has to-day become of general adoption. Indeed it is safe to say that one of the most direct means of our national health at present is the enormous importation of wheat, meat, fish, milk products, and fruits. The diet of the common people in the Middle Ages in England was salted meat, and foods poor in protein, fat, and vitamin.

The Scourge of Leprosy

Leprosy, like pellagra, was not improbably due to dietary deficiency. It is a disease of semi-civilization. The primitive savage and the highly civilized seem to be immune. The disease of leprosy no doubt existed in England from the fifth century A.D.—it was characterized by uneven tuberosities, thick coarse skin, raucous voice, loss of nervous

sensibility in hands and legs, atrophy of certain muscles, hypertrophied tissue breaking down into foul discharging sores, mortification. With leprosy were grouped, however, many and various morbid conditions which appeared to simulate it. Leprosy was common in India (according to Susruta) as early as the sixth century B.C. and prevailed in Egypt and Asia Minor in the time of Hippocrates. It spread from the East along the Mediterranean coasts in a most insidious and sluggish manner. It seems to have become established in Europe about the second century of our era, and was in Spain, Gaul, and Ireland as early as the fifth. It may have been extended by the Mohammedan invasion from North Africa to Europe but was certainly existent long before the Crusades. As in the East, so in the West, its occurrence in the individual was frequently attributed to an infringement of the current code of morals, totem, or religion. This supposed origin had the advantage of inciting in the virtuous the exercise of charity, and the disadvantage of placing a complete embargo upon the victim, reducing his legal rights, depriving him of his property, and condemning him to civil death.

The prevalence of leprosy in England from about the tenth to the fourteenth centuries furnishes us with an instructive chapter in the history of Preventive Medicine. The disease came to us late in its occupation of Europe, and we learned from other nations the means of its control. Partly because of its alleged association with immoral conduct, the Church rather than the State took action against its spread. From the sixth century onwards to the thirteenth, Church councils and popes intervened and debated upon it, and took various degrees of action. The Church councils at Orleans in 549, at Lyons in 583, and at Worms in 868 were forerunners of the great Lateran Council in Rome in 1179. In England too, Church ordinances and municipal regulations followed suit. In 1346 an ordinance of Edward III required the exclusion of lepers from London. The fundamental principle of nearly all these edicts was, in pursuance of the Mosaic Law, the exclusion of the leper from human society. Marriage was prohibited in 660, and 'divorce'

permitted (as in the Koran) a century later; the leper had to wear a prescribed dress, was furnished with a staff and warning rattle, and might not speak to others, or drink at the public fountain, or enter an inn; nor was the leper allowed to enter the churches, and hagioscopes (or squint-windows) were provided by which from the outside he might witness the raising of the host; he was likewise to be excluded from the towns, and lazarettos were provided for segregation at their gates; local taxes and tolls were to be raised on his behalf, prescribed amounts were to be taken from each wholesale quantity of food entering the town; and charitable alms and relief were to be furnished to lepers in the name of appropriate saints, St. Elizabeth, St. Louis, and St. Francis. The Franciscans were, as is well known, devoted to the service of lepers, and were so bidden by Francis of Assisi, who more than any other man of his time aroused public interest in their welfare.

The result of the charitable action of the Church throughout Europe led to a vast and continuing amount of public attention being devoted to this disease and the establishment of leper houses and hospitals, generally placed near the entrance to the towns under the guardianship of a 'master'. It is believed that in France and Germany at the height of its prevalence there were no less than 20,000 isolation colonies and leper houses. Probably not less than 200 leper houses were erected in Britain, sometimes provided or maintained from charitable sources, sometimes financed out of rates and taxes. No doubt these institutions played an important part in the restriction of leprosy and kindred maladies, and in some cases they provided something in the nature of medical inspection and treatment, the method of examination being particularized and formulated by Guy de Chauliac. But complete segregation and isolation were not carried out. Medical opinion in the Middle Ages held that leprosy was hereditary, definitely contagious, and generally incurable. It was recognized that certain foods and dietary increased the disease. The Mosaic Law, though accepted in principle, was not strictly applied outside the Jewish community. Yet it had a profound and widespread effect.

The causes of the decline in leprosy in Europe have long been a subject of medical speculation. It is beyond doubt that much was done in relief of the leper all through the Middle Ages, and it is equally beyond doubt that as an endemic disease it disappeared. Some facts seem to be established. Where isolation was most complete leprosy declined—and this has been confirmed in modern times by the experience of Norway. Sudhoff holds that by its application of the Mosaic Law to leprosy the Occident triumphed over the disease. 'Guided by this intellectual torch it accomplished the first great feat in direct prophylaxis: methodical eradication of leprosy by consistently making the affected individuals harmless as carriers of the virus.' Not only was there thus a greater or less degree of isolation from the rest of the community all over Europe, but cohabitation and sexual promiscuity were prevented, a very important factor. In civilized countries having temperate climates there seems to be a natural tendency for leprosy to die out; this may well be due to a declining virulence and to the beneficial effect of improved social and personal hygiene and a suitable detergent dietary.

It is now recognized that leprosy needs a number of factors, beside the presence of the bacillus leprae, working together to produce it, and if and when these factors disappear leprosy declines. Among such factors are sensitiveness to nervous disease, unsuitable dietary (much salted or toxic meat or fish, insufficiency of good bread, vegetables, and fruit), sexual promiscuity, unsuitable clothing, and uncleanliness. It is possible that the widespread and rigorous regulations against leprosy in Europe in the Middle Ages proved beneficial not so much, or not only, in their isolation value but as an indirect and long-pressed method of selective protection, enforced hygiene, and improved environment. Be that as it may, it is significant and deeply interesting to observe that many of the restrictions placed on lepers in Europe in the Middle Ages are similar to, and some of them identical with, the prophylactic methods which Dr. Mayer has recently reported as successful in preventing the spread of leprosy in Nigeria.

The Black Death

The calamity of the Black Death in the fourteenth century was the first great example which history has afforded of the scourge of world-wide disease. There had indeed been some premonitory signs of its advent, but they had been unobserved or disregarded. There had also been a dozen years of prevalent famine sickness, but the epidemic itself seemed to appear suddenly, a cloud rising in the East.

Coming from Asia, and possibly even from China, the first centre affected in Europe was probably at trading ports on the shores of the Black Sea in 1346, from which it was carried by ships to Constantinople, thence into the Mediterranean basin, and thus was it primarily sea-borne all round Europe. It was reported, for instance, that in January 1348 certain galleys 'laden with divers spices and other weighty goods, horribly infected' touched at Genoa. Owing to the sickness and death on these ships they were 'driven forth from that port for no man dared touch them, nor could any man deal with them in merchandise but he would forthwith die'. Thus they were scattered, some to Marseilles, some to Spain, some elsewhere. Galleys were found drifting hither and thither about the sea with their cargoes but with every man of the crew dead on board.

From port to port round the Mediterranean and up the Atlantic sea-board infection was thus carried. It reached England in August, at ports in Dorset and Devon—possibly first at Melcombe in Dorset. It passed by land to Somerset, to Bristol, Gloucester, Oxford, and reached London at Michaelmas 1348. Other channels of infection came to England overland through Italy, Provence, and Gaul. It is from the chroniclers in Italy and Provence that we get the earliest accounts of this vast oncoming tide of disease and the havoc which it left behind.

Giovanni Boccaccio, the Italian novelist, was living at Florence between 1348 and 1358, and was engaged in writing the 100 tales of the *Decameron*. In its preface he provides an invaluable contemporary account of the Black Death as it occurred in Florence, the authorities of which

had done their utmost to safeguard their city against its invasion.

'No physician's counsel, no virtue of medicine whatsoever, seemed to have any effect or profit against this sickness, whether from the intractable nature of the plague itself, or from the ignorance of the practitioners; for, beyond the number of learned physicians, there came forward a multitude both of men and women who had not the smallest tincture of science, who, in their ignorance of the cause, were consequently helpless to draw the proper conclusions; so that not only were cures few, but almost all died within three days of the appearance of the fatal signs, some sooner and some later, without any fever or other contributory cause. And this pestilence was all the more violent, because, by communication from the sick folk to the sound, it spread no less rapidly than a fire will spread to dry or oily things that lie close at hand. And, worse still, not only did the speaking or association with sick folk bring disease to the sound, or involve both in one common death, but even to touch their clothes, or anything else which the sick had touched or handled, seemed in itself to convey the same sickness to him who had touched.

'It is a marvel to hear that which I am bound to say; a thing which, if mine own eyes and my friends had not seen it, I should scarce have dared to believe or write, howsoever worthy of credit might be the man from whom I had heard it. I say, so potent was the nature of the aforesaid pestilence in its communication from one to another, that not only did it pass from man to man, but, a far stranger thing, the effects of a sick or dead man, touched by an animal apart from the human species, not only contaminated the beast, but slew it within a very short space; whereof I bring forth here an experience which, among others, mine own eyes have seen. The rags that a poor plague-stricken man had worn were cast into the open street; presently there came two swine, who, after their wont, first scratched among them with their feet and then shook them in their paws. Then they staggered for a while, and within a very brief space, as though they had taken poison, both fell to the ground upon those rags among which they had rummaged to their own destruction.

'From these things, and others similar or worse, there arose divers fears and phantasies among the survivors; and all these tended to one most cruel end, to wit, that they should flee from the sick and from all things belonging thereto; by this means each hoped to win his own safety.

'Some there were, who thought that moderation in diet and the

avoidance of all superfluity would be greatly efficacious against this calamity; therefore they formed companies which lived apart from all other men, shutting themselves strictly in houses that were free from all sickness, wherein they lived richly but most temperately upon the most delicate meats and the best of wines, avoiding all lechery, refusing to speak with other folk, excluding all tidings of death or sickness without, and enjoying such music and diversions as they could command.

'Others, drawn to a contrary opinion, preached that the best medicine for this plague was to drink deep, to enjoy life, to go their way with singing and solace, and to satisfy all their appetites as fully as they might, laughing and mocking at the worst that might befall; and, even as they preached, so they acted to the utmost of their power, straying by night and day from tavern to tavern, drinking beyond measure and limit. Moreover, they did this by preference in other folk's houses, just as the whim or the fancy took them; for every man, expecting death in the end, had, as it were, abandoned his own house, so that most of the habitations had become, in a sense, common property, and any stranger made as free use of them as the lawful owner; and the men of whom I speak, in all their bestial purpose, always avoided the sick to the utmost of their power.

'And, in this great affliction and misery of our city, the reverend authority of the laws, divine and human, was almost wholly ruined and dissolved by those who should have administered and executed them; for these ministers, like other men, were all either dead or sick, or had lost their servants so that they could not execute their office; wherefore every man was left free to do whatsoever his own pleasure might dictate.'

Boccaccio found that in Florence as elsewhere in Europe poverty accentuated suffering.

'The case of the poor, and perhaps of most of the middling folk, was far more wretched; for most of these men were kept at home either by hope or by poverty, and, in those close quarters, they sickened daily by thousands, and, for lack of service and all else, almost all were irrevocably doomed to death. Many breathed their last in the open streets by day or night; many again, though they ended in their own dwellings, gave the first notice of death to their neighbours by the stench of their rotting corpses; and, whether in this fashion or in that, death reigned everywhere. In general, the neighbours always followed the same course, impelled no less by fear of harm from the corruption of the corpses than by such charity

as they felt for the dead. Either with their own hands or with the help of porters, when such could be got, they dragged the dead bodies from the houses and laid them on the threshold, where, especially in the morning, passers-by might see them lying without number. Then they fetched biers, or sometimes, for lack of better, laid them on a bare board. Nor was it unique for one bier to bear two or three corpses, nor did it befall once only, but you might have numbered many cases where wife and husband, two or three brethren, or a father and son, or suchlike were laid together. . . .

'In the churchyards, thus filled to overflowing, great pits were dug, wherein the bodies were laid by the hundred as they arrived. In these they were packed in layers, even as men pack bales in a ship's hold, and were covered with a thin coat of earth until they mounted to the edge of the pit. . . . Nor were the country districts spared; for (apart from the market towns, which, on their smaller scale, suffered as the city did), throughout our scattered villages and homesteads the wretched labourers and poor folk, with their families, died without any help of physician or succour of servants, breathing their last by the roadside or among their crops, or in their cottages, by day and by night alike, not like men, but almost like beasts.'

I have quoted this description at some length as it is one of the classical and graphic records of a living witness, which represents what happened throughout Europe.

Many attempts have been made to estimate the number of people thus destroyed. It is possible that chroniclers of the time were so overwhelmed that their reports are exaggerated. It is said that in not a few cities the number of people reported to have died exceeded the population. Owing to the use of Roman rather than Arabic figures and other false estimates, miscalculations may have occurred. It may well be so, but we must not overlook the fact that the poor country folk swarmed to the towns in the hope of finding refuge or in search of the protection of the Church and its saints. The rich might have fled to their country houses as did Boccaccio's heroines, but not so the poor. But whatever allowances may be made, it can scarcely be doubted that in many parts of Europe from one-third to one-half of the population was destroyed. Mr. Coulton and other historians think that the general mortality among incumbents of churches exceeded 40 per cent. and that the

Black Death created vacancies in nearly half the parishes in England. 'We cannot doubt on a general survey,' says Mr. Coulton, 'that this frightful calamity dealt a severe blow to the prestige of all authorities, and most of all to that authority which claimed widest sway over men's bodies as well as their souls, the Church'; and Dr. Creighton considers on the whole the evidence shows that 'the mortality was about one-half the population'.

We have many descriptions which establish that the Black Death was, like the pestilence of Justinian, bubonic plague. Guy de Chauliac, Boccaccio and Villani of Florence, Geoffrey Le Baker, Clyn, and later Dr. Gilbert Skene, Dr. Thomas Lodge, and Dr. Woodall are all agreed as to this, and the indisputable evidence of buboes in the axilla or groin, the carbuncles, the black pustules, the vomiting of blood, the devouring thirst, leave little doubt as to diagnosis. Here is a contemporary account by Dr. Cauvin of Paris and Montpellier:

'A burning pain, starting either in the groin or under the armpits, gradually spread over the precordial region, and the vital parts were attacked by a mortal fever. The heart and lungs were affected and the respiratory passages were choked with the poison. The strength suddenly declined and the patient could only survive a few days. There seemed no refuge from this scourge, neither heat nor cold, nor the fresh country air, the cold north or the warm south. So contagious was it that when the sickness commenced in a house scarcely one escaped. The slightest contact, a single breath, sufficed to transmit the disease. Those who tried to aid the sick fell victims. The ill nourished were easily stricken. Those who lived a temperate life fared best. The number of the dead was greater than the survivors, and cities were deserted, thousands of houses standing with open doors or locked up, their owners dead or fled.'

There is also authentic evidence that the plague of 1665 was the same malady as the plague of 1349. Some medical authorities believed it was 'a fixed and uniform entity', whilst others favoured the theory of 'a scale of malignity' which passed from a simple continued fever at one time into 'a fever with buboes', the true plague, at another, and that such development was due to change of season or soil-poison, to accumulation of infection, or to susceptibility of the victim.

The Effects of the Plague

We must now consider the effects of this pandemic on the social life of the people, and what was attempted to rid the world of such a scourge. In order to bring the account within brief compass we will restrict ourselves to the social changes which resulted. After what has been said we may take for granted that the Black Death was the *bubonic plague*, and that its mortality depopulated this country by one-third to one-half, that is to say, in 1348–9 it reduced the population from approximately four million to two million people. Famine, war, and pestilence have wiped out civilizations in former periods of human history. The plague in the time of Justinian, dragging on as it did from 542 to 594, may have taken, as Gibbon believed, a toll of 100 million lives. From Persia to France it changed the direction of human history. The Black Death of the fourteenth century also did much to depopulate Europe. And it did another thing having far-reaching effects, it *domesticated plague in England for 300 years*. Year after year from 1348 to 1666 there were cases of plague in London, sometimes as many as a thousand in number. It never swept the whole country again as in 1348–9. But it remained, and it broke out from time to time in severe or less severe degree and type. Here is a significant list of dates. There were epidemics of plague (*pestis secunda* to *pestis quinta*) in 1361, 1368, 1375, 1379, 1381, 1391, 1405–7, 1413, 1420, 1433, 1444, 1461, 1464–78, and so on all through the sixteenth century, to be followed again in 1603, 1625, and 1636. The English records are, as Creighton said, invaluable as demonstrating beyond doubt the continuance of plague infection in England from 1349 to 1666. It bred sickness and misery, it checked constructive polity, it engendered a sense of fate and uncertainty, it hung like a sword of Damocles over the heads of the people.

The social revolution produced or accentuated by the Black Death was mainly due to one effect, namely, *depopulation*. Its first and obvious result was emptied houses, abandoned towns, neglected agriculture, 'a vast and desolating solitude over the world' as described by Petrarch, who

witnessed the devastation produced by the plague in Italy. But it had more enduring effect. For so vast a depopulation paralysed all forms of productive industry, whether in workshop or on the land; it altered the economic basis of the nation, for it redistributed wealth and poverty, and expedited the rise of the yeoman class; it mobilized the remnant of labourers and redirected their labour; the arable land went out of cultivation and sheep farming and pasturage were substituted for land tillage; it left its immediate mark on wages, on prices, on rents, on taxes, and on land tenure; it stripped the old governing classes of their authority and disorganized the municipalities and the guilds; it accelerated the break up of the manors and the deterioration of the monasteries; and it brought demoralization in its train.

It had also a strange psychological influence. Fatalism became dominant, and laxity of morals increased. Some were sobered and looked forward prudently, others rapidly degenerated. By hereditary succession many of the poor became rich, and their suddenly acquired wealth was squandered in extravagant and licentious living. Self-restraint and fear of God and man were reduced, and discontent and inarticulate desire for change were increased. There were, of course, more remote effects of another character. Institutions founded solidly on deep human needs, and movements inspired by deep human instincts and aspirations, moved forward. The need for municipal growth and organization became more obvious, and the need kindled desire and growth. In a word, the Black Death fell upon a world which was already in process of change—where seeds of decay were already sown in manor or monastery, in economic state and religious institution, this cataclysm brought forth a harvest of fruit or of tares; where wise design had constructed for the future its building was fortified. Mr. Coulton claims that the Black Death tended 'to hasten the impulse of independent research which we call the Renaissance and that religious revolution closely akin to it, which we call the Reformation'. Whatever were its immediate and remote effects we have in the Black Death the greatest social example of the influence of disease in the destiny of nations.

England's Action

We may well ask ourselves what England did at this critical juncture of its fate. How did it learn to fight and control epidemic disease? The answer, in a word, is that it commenced in earnest the great business of *defence*. As flight had been accepted as the sovereign method of escape from the infection of plague, so constructive defence was sought as the method of prevention. There had been Church ordinances against pestilence for a hundred years before the Black Death. But now something more became necessary. In 1350 there was a royal proclamation against emigration and the inflation of food prices, and in behalf of a regularization of wages. Whatever the despair or confusion in men's minds, whatever their doubts, four facts seemed to them settled and sure. The plague was an imported affliction; it was highly contagious and infectious; poverty, squalor, and miserable domestic conditions obviously favoured it; and there was almost complete absence of effective treatment or prevention. The more enlightened came to believe that sprinkling a house with vinegar and rose leaves was as futile as remaining in the infected house. The Black Death came to an end, in 1349 and 1666, not on account of direct action taken but because it had spent its force and exhausted the susceptible material.

The first preventive step necessary was *sanitation*. It took Europe a long time to recover from the fall of Rome, and when leprosy and the Black Death became prevalent her towns and cities discovered that they were squalid and insanitary. Narrow unpaved streets, open drains, collections of filth, refuse, and offal, dark and overcrowded wooden dwellings with rush-strewn floors, ill ventilated and unclean and shared with animals, an absence of adequate water-supplies. The French wars of Edward III had been interrupted in 1349 by the Black Death, and the king and his advisers began forthwith to consider both its reduction and its effects. The war required more men, and the labourers an assured wage. This idea materialized in various ways. In 1349 came the Statute of Labourers, and

a little later ordinances for improved sanitation culminating in 1388 in the first Sanitary Act of Parliament, designed to abate numerous insanitary nuisances. Amendments of this Act followed in 1415 and 1488 and again in 1495 and 1540, leading up to the vigorous sanitary and housing policy of Elizabeth. In fact, at last, the imperative necessity of a sanitary environment was recognized. Nor were the people much better than their environment, for there was a serious lack of personal hygiene with deficiency and insufficiency in dietary, leading to poor physique and much ill health.

A second requirement was the proper *supervision of the infectious sick*, by 'searching', by notification, by isolation, by marking of infected houses, and above all by a popular understanding of the ideas conveyed in the terms of infection, contagion, transmission, and susceptibility. There were penalties for concealment of cases. The first we hear of these methods officially was in 1480, and subsequently in a charge made in 1518 by Sir Thomas More to the Mayor of Oxford that inhabitants infected with the plague shall keep in their houses, 'put out wisps and bear white rods'. They are forbidden to keep animals in their houses and officers are required to keep the streets and lanes of the town cleansed and burn refuse by fires. This sort of regulation was later enforced by registration of deaths, beginning in 1539, and by the plague 'orders' (1543), and adopted in the Elizabethan regulations. The white wand became the peculiar badge of the 'searchers' of infected houses (which had to be marked and closed) and the bearers of the dead. Additional orders which were promulgated by the Corporation of London in 1568 and 1581, included burning of infected clothing and bedding, cleansing of streets, closing infected houses for forty days, and many petty regulations in regard to scavenging and sanitation. The statute of 1488 enacted special control of slaughter houses which had become a public nuisance; another in 1495 dealt with 'corrupt bed-stuffs' used by upholsterers; and a third in 1540 concerned scavengers of filth whose delinquencies had been vigorously criticized by Erasmus in a letter to Wolsey's physician. Similarly, in 1582 the Privy Council itself had

intervened owing to the non-observance of 'orders for the prevention of infection', and later on the provision of isolation 'cabins' and pest-houses. .Lastly, action was taken to reduce the careless disposal of the dead and the overcrowding of churchyards with plague bodies. Here then are examples of the efforts of Tudor legislation against plague infection. Their doctrines were taken from a substantial corpus of plague tractates of great interest, issued broadcast at the time. The College of Physicians issued pronouncements in support of these general measures in 1630, and some years earlier medical men were appointed to advise in prescribed quarters of London.

A third step in reform was the beginning of formal *quarantine*. When it became obvious to all concerned that plague passed from port to port, and was thus conveyed from the Levant to the coasts of other countries, the great maritime powers introduced a system of quarantine, an initiation of an international sanitary cordon. Venice, the Queen of the Adriatic, began in 1374, and its practice was quickly followed at Ragusa on the Dalmatian coast in 1377 and at Marseilles in 1383. Incoming ships and passengers from the East were trentined and quarantined for thirty or forty days respectively. The ships were opened to sun and wind, and were also fumigated. A hundred years later Venice set apart special sanitary officers at ports to ensure effective quarantine practice.

England learned in the Middle Ages to begin the control of epidemic diseases by social defence. She had little or no science at her disposal, and her doctors were insufficiently equipped to render effective aid. But she had social aspirations, practical common sense, and some inventiveness, and a political system which had grown out of her own experience in the manor estate of feudalism, in the utilitarian services of the monastery, and in her local trade guilds. Through much suffering from food deficiency or insufficiency she learned the necessity of effective agriculture and food importation; from leprosy and plague she had an empirical and experimental understanding of the contagiousness of disease. In the fourteenth century, and still

more in the seventeenth, though she learned so little scientific Preventive Medicine, she saw the need and occasion for State intervention through customary law and statutory regulation. From all this, and from their own sanity and sense of practical action, the English people recognized the importance of the ascertainment of the incidence of disease, its notification, its personal and communal infectivity, the isolation of its victims, and of the need for quarantine. This was a substantial advance on the practice of neglect, or excluding the victim from the towns, or hanging him on the gibbet.

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VI

THE RENAISSANCE AND THE RISE OF PHYSIOLOGY

'*The medieval heritage of Greek science and the Renaissance heritage of Greek literature proved barren of themselves. It was not until the one fertilized the other that there was real and vital growth.*'—CHARLES SINGER, 1923.

Synopsis of Lecture VI

The Renaissance was an efflorescence from many roots: the Arabic infiltration; the influence of the twelfth and thirteenth centuries; monasticism and the rise of the Universities; the benevolence of Louis, Innocent III, and Francis of Assisi; the unity of the Papal Church; Thomas Aquinas, Roger Bacon, and Robert Grossetête; the art of printing; the fall of Constantinople; Erasmus and the Oxford Reformers (Linacre, Colet, More); the Medici at Florence.

The basic study of the Nature of Man, the contribution of the Renaissance.

The advance in Anatomy.

(*a*) The pre-Vesalian Anatomy. Galen and Mundinus.

(*b*) The great painters: Giotto, Leonardo da Vinci, Dürer, Michelangelo, Titian, Calcar. What they did for Anatomy.

(*c*) Andreas Vesalius at Padua. *De fabrica corporis humani*, 1543.

'*My love of knowledge so inflamed me that my work was retarded by my very desire.*'—Petrarch.

William Harvey and the Circulation of the Blood. Harvey at Padua (1600–2). The Lumleian Lectures in London, 1616, *De Motu Cordis et Sanguinis*, 1628. The differentiation between Galenic and Harveian blood systems. The essential points of Harvey's demonstration (the mechanism of the circulation, the nutrition of the body, the end of spirits, the experimental method).

The new physiology which resulted from Harvey's work.

Claude Bernard's 'constant internal environment'. Its relation to Preventive Medicine.

VI

THE RENAISSANCE AND THE RISE OF PHYSIOLOGY

From the earliest times of man's history to the New Birth of his mind, which we call the Renaissance, the knowledge which he possessed of Preventive Medicine had been essentially empirical. There had been, of course, many trials and tests, even many logical experiments, since the days of Thales of Miletus, but speaking generally what men knew they had learned in the slow and hard school of experience, an experience which they applied to the immediate problems before them without consciously using a scientific method. There were exceptions, from Galen to Roger Bacon, but they were exceptions and not the rule.

After the Renaissance the way of approach and of subsequent study was conceived of as an attempt to pursue the scientific method. There was an ever-increasing record of medical facts, of which Galen's voluminous writing had been the standard example. At the Renaissance such records were illuminated, as it were, interpreted and revitalized. 'The medieval heritage of Greek science and the Renaissance heritage of Greek literature', writes Singer, 'proved barren of themselves. It was not until the one fertilized the other that there was real and vital growth.' When we come as students of Medicine to see what this meant we shall find that for us the Renaissance meant *the basic study of the nature of man.* For our forerunners this was the supreme discovery of the Renaissance, and we should be wise to make it the supreme rationale of the principles of Preventive Medicine. I can well understand the casual onlooker asking what have magic, or the Pentateuch, or the Greek spirit, or the Saracens, or the monasteries of the Middle Ages, or the art and literature of the Renaissance, to do with Preventive Medicine? Now the answer to this question is that the foundation of a science and art of Preventive Medicine can only be truly laid on our understanding of physiology, the word of life. The historical attack upon

disease and the social defences set up against it are examples of man's attempt to control it. He has tried many methods, most of them empiric; the only methods which are either effective or enduring are, in fact and in purpose, based upon his knowledge of the nature of man. *Nutrition* and *immunity* are perhaps the master instruments hitherto discovered.

Our task is to explore the way by which such principles have been won. It is true they have been operative since man's life began on the earth, but it is only by the application of the scientific method that we learn to understand them, what they really are and how they work. To improve the external environment of man by housing and sanitation has been a practical method of bettering his nutrition and powers of resistance. But we must not be content with that empirical experience, we must find out the why and the how. And to achieve this we must explore his arts and literature, his inventive civilizing propensities, even his psychology. Above all, and now more than ever, we must anchor always in the nature of man's body.

The Renaissance was an efflorescence which sprang from many roots—the Greek spirit and its curiosity and freedom; the Arabic infiltration; the influence of the twelfth century and its manors, monasteries, and guilds; the rise of the universities, and the unifying agency of the Papal Church; the rich thirteenth century, Louis, Innocent III, Francis of Assisi, Thomas Aquinas, Roger Bacon, Robert Grossetête, as well as the Great Charter of England; the Black Death; the arts of painting and printing; the fall of Constantinople; the voyages and discoveries of the world; the Medici at Florence and the Oxford Reformers. The spirit of the Renaissance thus showed itself in various forms and in different representatives. Dante thought that Francis Bernardone of Assisi was its rising star, but it had also other and quite different exponents, each embodying some measure of its glory and freedom; Roger Bacon and Leonardo da Vinci had the Greek sense of science inspiring their genius; Innocent III and Grossetête, the famous Bishop of Lincoln, though opposed as papist and protestant, shared in common the service of spreading a love of learning; Linacre, Colet,

Erasmus, and More, though great personal friends, possessed wide diversity of gifts; the Aldine printers lived in a world remote from that of the early navigators, but were none the less adventurers; the synthetic painters like Leonardo and Albrecht Dürer, and the analytical experimenters who followed Harvey, each had a contribution to make. There was obviously no single school of the Renaissance as there were Hippocratic or Alexandrian Schools. Probably the nearest approach to such a concentration was the Platonic Academy established by the Medici in Florence, of which I will speak later.

Leonardo and the great Painters

It is instructive to observe that it was not the doctors but the painters who first opened the eyes of men to the beauty and balanced organization of the human body. Giotto (1276–1336) was their prophet. He was found by Cimabue as a shepherd boy drawing pictures of his sheep on the smooth stones of the field, and was taken and trained in Florence. He became, as we all remember, the first great artist to realize the necessity of functional and purposive lines in representing the configuration of the body, and this was the seed of the Florentine flair for anatomy. He proved himself in the Arena Chapel at Padua and in the upper church at Assisi to be 'the disciple of Nature', and his followers and pupils taught the anatomists of that day. Pollajuolo studied the skeleton and muscles, Verrocchio made casts of the living body, Leonardo da Vinci unveiled for all men its structure. Indeed, in 1303, the painters became incorporated in the Guild of Physicians of Florence. They awakened and inspired them, and they taught them anatomy.

The most epoch-making of the painters from our point of view was Leonardo da Vinci, who was born in 1452 at Vinci, half-way between Siena and Florence. He had remarkable parents, Piero and Caterina, who acquired fame by his birth, and at the age of 18 he entered the bottega of Verrocchio in Florence, and worked in that city for a dozen years. He was a true Florentine by adoption and in

spirit, and whilst he spent much of his time, and did much of his work, in Milan, as a student of anatomy, as a painter of the *Last Supper* in the Santa Maria delle Grazie, and as a sculptor, in Venice as a painter employed by Isabella d'Este, and in Pavia with his friend Antonio della Torre, professor of anatomy in the University, he represents the great anatomical thinkers and artists of the Florentine advent, and he left it the enigmatic smile and unfathomed charm of *Mona Lisa*. Sudhoff agrees with William Hunter that he was 'the greatest investigator of anatomy and physiology in his period. No one since the days of Galen and the Alexandrian anatomists, no one before Vesalius, ever dissected the *human* body with such patient and purposeful zeal and ability.'

Fortunately Leonardo was a diligent note-maker, and recorded his anatomical work in writing as well as in drawing. His dissecting was done at the hospital of Santa Maria Novella in Florence, then at the Ospedale Maggiore in Milan, and lastly in the Santo Spirito in Rome. He left behind, in thirty years, some scores of volumes of such notes, with 750 drawings, and from these we know how wide and deep was his knowledge of anatomy. He depicted from his own dissections the skeleton, the bones, joints, tendons, muscles, the heart and lungs in all their parts, including the valves and moderator bands in the walls of the heart, the arteries—on which he observes 'the imperceptible bleeding of the capillary veins'—the eye, the uterus and embryo, the ventricles of the brain. But he did much more than this, for he was the first anatomist who experimented as to the function of the organs he dissected, and associated the relation between structure and function—the part played by function in the evolution of structure was to come later.

Nor was he anatomist only, for his versatile genius roved freely into the regions of all knowledge, anatomy, physiology, mathematics, chemistry, geology, botany, astronomy, geography, physics, and art. He designed flying machines and war engines. He knew no bounds and kept none. Though he did not demonstrate the circulation

of the blood, he notes in 1489 that by means of the beating of the heart there is produced a wave of blood in 'all the veins and these are continually either enlarging or contracting, and this the beating of the pulse teaches us', and he goes still farther in anticipation of later discoveries by adding, 'I say that the flesh of animals is made anew by the blood which is continually produced by that which nourishes them'. Such was the forerunner of Vesalius and Harvey. He ended his days at Amboise on the Loire in 1519, one of the greatest and most fertile minds among men.

There were four things which the Renaissance painters did for the advance of anatomy and physiology. They studied anatomy to improve their art; they taught its study by dissection and the drawing of the nude; they guided the public taste in favour of the art of Nature; and they illustrated text-books of anatomy. 'It is a necessary thing for the painter,' notes Leonardo, 'in order to be able to fashion limbs correctly in the positions and *actions* which they can represent in the nude, to know the anatomy of the sinews, bones, muscles, and tendons, in order to know in the various different movements and impulses which sinew or muscle is the cause of each movement.' He playfully adds that those artists who fail thus to equip themselves 'make their nudes wooden and without grace', rather like 'a sack of nuts than a human form, or a bundle of radishes than the muscles of nudes'. If one sets out in chronological order from 1450 to 1550 the anatomical artists and the medical anatomists one may study the effect of the teaching of the one upon the other: Pollajuolo, Verrocchio, Signorelli, Leonardo, Albrecht Dürer, Michelangelo, Titian, Calcar, and Tintoretto on the one side; and Mondini, Manfredi, Carpi, Servetus, and Vesalius on the other.

Perhaps for us Dürer of Nuremberg (1471–1528) comes next in importance to da Vinci. He worked with mathematicians and physicians in Nuremberg, Augsberg, and Strasbourg, but he also re-inspired the anatomists of Padua and Venice. His paintings of the bath-tub, the syphilitic man, and Adam and Eve will remain for ever as evidence

of his apprehension of anatomy; and his woodcuts of the stories of the Gospels, which circulated in Germany, and afterwards all through Europe, taught the public for the first time in a popular way the true features of their own anatomy. No other painter, with the exceptions of Giotto, Leonardo, and Michelangelo, taught the public more than did Dürer. Lastly, you will remember that the marvellous illustrations in the *Fabrica* of Vesalius, which did so much to make that book pre-eminent, were the handicraft of Jan Stephen van Calcar, the Flemish painter, friend and fellow countryman of Vesalius.

The Medici at Florence, and Thomas Linacre

In the Duomo at Florence there met in 1439, in the days of Cosmo de' Medici, the great Council of the Church under Pope Eugenius IV. This Council is of particular and significant interest to us, for it proved the seed-ground of the Platonic Academy of the Medici, which exerted an influence that altered the course of English Medicine. For the purpose of conducting their debates each of the parties had selected representative disputants eminent for their rank and learning. Among those chosen on the part of the Greeks were Gemisthos Pletho of Constantinople and Cardinal Bessarion. The issue in Florence, according to Villari, was whether Nature be the manifestation of a divine and universal spirit informing and ruling the world, or whether Nature was merely the blind operation of mechanical laws of matter, primary issues for the Italian Renaissance; and Gemisthos won the interest of Cosmo de' Medici for the establishment of a Platonic Academy in Florence. Cosmo had for many years before and after the Fall of Constantinople in 1453 collected Greek manuscripts, a passion which, owing to his Venetian interests and extensive mercantile intercourse in Europe and Asia, he had been able to gratify beyond others. Correspondents, emissaries, and travellers procured for him invaluable literary treasures in Greek and Arabic languages, with which he founded the famous Medici and other libraries—and these contributed to the Academy studies in Medicine.

Cosmo died in 1464 and was succeeded in the city guardianship by his son Piero, and in 1469, by his grandson Lorenzo the Magnificent, during whose governance of Florence the Platonic Academy flourished until the zenith of Savonarola in 1496. At its head was Ficino, son of Cosmo's private physician, a recognized authority on Plato and Plotinus. In its service were engaged many illustrious writers and teachers, chief among whom were John Argyropolos, the Aristotelian, and Demetrius Chalcondyles and Politian, the Platonists. Lorenzo's sons, the intellectualists of the greatest families, including Pico della Mirandola, and not a few foreign visitors, became pupils of the Academy. We have a panoramic record of these students and their teachers in Gozzoli's famous fresco of 'The Magi' in the chapel of the old Medici Palace in Florence. It was a gay and pagan world of carnivals, masquerades, tournaments, revelry, and dissipation, in the midst of which a mighty transformation of the human mind was already in progress. Its setting was the garden of Florence. Into this beautiful city of flowers, colour, and song there came about 1485 a grave, studious, and sober-minded Englishman, Thomas Linacre.

Linacre, the medical pioneer of the Renaissance in England, was born at Canterbury, probably in 1460, and went to the monastery school at Christ Church, Canterbury, under the priorship of William Selling. At the age of 20 Linacre removed to Oxford, which became at that time an English home of Greek learning. Under Vitelli he studied Greek in company with Grocyn and William Latimer, and became an accomplished scholar. When Archbishop Warham appointed Selling as an ecclesiastical ambassador to Rome, Linacre accompanied him, and by him was introduced to Ficino, Politian, and the Platonic Academy at Florence. He was patronized by Lorenzo de' Medici, and became the companion and fellow student of his sons, Piero and Giovanni, and the pupil of Chalcondyles and Politian, who left an enduring mark, the love of learning, upon him. It is as if he came out of the shades of scholasticism at Oxford into the sunlight of a larger life and a wider purpose. At

Rome he met with Hermolaus Barbarus, with whom he contracted a close and fruitful friendship. Barbarus was a student of scientific and medical literature, a devoted translator of Aristotle, Dioscorides, and Pliny, and held a Chair in the University of Padua. He was a follower of Aristotle. He died of the plague in 1494, aged 40. From Rome Linacre went to Padua, where he first really studied Practical Medicine, and took the doctorate degree. Thence by Vicenza and through the Cevennes he returned to London.

Happy is the student who at an early stage in his studies receives the inspiration of great purpose and the contact of great minds. It is the dynamic of all true education. Linacre took with him to Italy a scholastic grounding in the classics; he brought back with him a living comprehension of the service which Greek learning could render to English Medicine, of the essential importance of Hippocrates and of Aristotle, and of the necessity of a reorientation and reorganization of medical knowledge.

When Linacre came back to England he settled down again at Oxford, but as a teacher rather than an undergraduate, as a translator rather than a student, as a medical reformer rather than a schoolman. He was incorporated as M.D., and with Grocyn and Lilly he was recognized as one of the pre-eminent introducers of Greek Medicine in England. He was, in fact, the first. He tutored Sir Thomas More, who came up to Oxford in 1499, and about the same time he had even more distinguished pupils in Erasmus and the young Prince Arthur of Wales, and subsequently he became physician to Henry VIII. These complimentary appointments brought Linacre to London, where he resided at the Stone House, Knightrider Street, near the court at Bridewell, in the vicinity of St. Paul's, and introduced him to a London medical practice, which though limited was in the highest circles. In accordance with the custom of the time, Linacre was scholar, physician, and priest, and was ordained by his influential patrons to eight different non-residential livings. He died in 1524 in his sixty-fourth year, and was buried in St. Paul's Cathedral. Inspired at Florence

as a Platonist, he became the principal initiator of the scientific movement which proved to be the turning-point in modern English Medicine.

Stimulated by Barbarus and the Medici School, as well as by his friends, Grocyn, Latimer, and Dean Colet, Linacre set to work to translate the Greek medical masterpieces in order to enlighten and guide medical men in England. He selected first, on the suggestion of Erasmus, Galen's treatise *On the Preservation of Health*, its foundation in nature, its art, its purpose, its priority over therapeutics. Then he translated Galen's *Method of Healing*, which was followed by his books on temperaments, on symptomatology, on the pulse, &c.

But the turning-point could not be reached only by translations of ancient learning. New learning must be acquired, a new transmutation of English Medicine other than Arabic must be established, and a new spirit such as had awakened Italy. We do not know what share, if any, Linacre had in the passage of the Medical Act of 1511, but it is certain that it stirred him to action. That Act was the second great step to medical reform after the Charter of the Barber Surgeons in 1461. It provided that no one should practise as physician or surgeon in London or within seven miles of its walls except he be examined and licensed by the Bishop of London or the Dean of St. Paul's with the aid of competent doctors of physic as assessors, and that in the provinces the duty of licensing medical practitioners should rest similarly with the bishop of the diocese. This was better than the previous unlicensed confusion, but Linacre desired to liberate medical practice from the control of the Church as well as to lead it into the paths of Greek Medicine. In a word, he saw that what was needed was an improved medical education. Hence he endowed medical lectureships at Oxford and Cambridge, and established a central academy of Medicine, which should be charged with the duty, foreseen by Frederick II in the thirteenth century, of licensing physicians who were medically competent. In September 1518, by royal letters patent, a charter was granted by Henry VIII to Linacre and five other physicians for the foundation of the College of

Physicians of London and for the regulation of the practice of physic in London and for seven miles round, and the punishment of offenders. Four years later these privileges were confirmed by statute and extended to the whole country. Linacre became the first President of the College, from 1518 until his death in 1524; to his munificence its establishment was due, and in his house its meetings were first held.

Beside the ostensible object of providing a statutory and scientific basis for qualification in Medicine, the College of Physicians exerted a powerful influence on its science and art. It liberated it from the control of the Church; it saved it from the leaden rule of orthodoxy which dominated the universities; it brought the competent medical practitioner into the learned world; it encouraged English physicians to study in the universities of Europe and brought foreign physicians into English culture; it was the first systematic plan of education prescribed in England for a faculty of Medicine. Out of it great things were to come. It knew the mighty secret. As Shakespeare wrote in *All's Well that Ends Well*:

> The congregated college have concluded
> That labouring art can never ransom Nature
> From her inaidable Estate.

Within a century it had built for itself a comprehensive institution for scientific advancement comprising anatomical and special lectureships, a physic garden, a museum, a library. Later on the College promoted the *London Pharmacopoeia*, and in the nineteenth century the registration of the cause of death, and a *Nomenclature of Diseases*.

By piecing together the scanty records which remain to us of Linacre's personality and achievements—his translations, his institutions, and himself—we shall find that, like Petrarch, he stood 'on a frontier that divides two peoples, looking both to the past and to the future'. As a humanist he followed where others had trodden. He joined with them in awakening the spirit of man to his literary inheritance. Though a medical practitioner in a pregnant time, he did not elucidate the processes of diseases; the great epidemics seemed to pass him by; he left no original

work, though no doubt he inspired the forward-looking ideas of Preventive Medicine which More, his friend and pupil, published in *Utopia*.

Vesalius at Padua

I turn now to the great anatomist who did for anatomy what his contemporary Copernicus did for men's knowledge of the cosmos, Andreas Vesalius of Brussels, whose father was apothecary to Charles V and his mother an Englishwoman named Isabella Crabbe.

From the age of the Alexandrian School and Galen to Mondini there had been no advance whatever in our knowledge of human anatomy. 'I had to put my own hand to the business', said Vesalius, and this he did when as a boy of 18 he went to Paris to learn under Sylvius. He stayed there four years and then migrated to Venice to take the M.D. of Padua. So promising and zealous had his work on anatomy been that the authorities made him Professor of Surgery and Anatomy at the precocious age of 22. That appointment in 1538, in the time of Ambroise Paré and Paracelsus, was to become famous not only in Padua but in the wide world of science. For young Vesalius was, within five years, to make himself illustrious. Padua stood at the dawn. From all over Europe young men were to cross the Alps to 'fruitful Lombardy' that they might 'see fair Padua, nursery of arts', although more than half a century was to pass before Shakespeare recorded the fact.

Vesalius began his professorship by teaching anatomy in a new way, which was to enable the student 'to study that true bible, as we count it, of the human body *and of the nature of man*'. Those are his very words, used in after years as he reflected on the golden past at Padua. This meant anatomy was not to be learned from Galen or any other writer, but by dissection and study of the dissected body. So Vesalius must beg, borrow, or steal all the dead bodies he could secure, in order that his students might see with their own eyes and handle with their own hands the structure of the body, for though their conception of physiology might be Galenic their knowledge of human anatomy

must be their own. Vesalius prepared some 'anatomical tables' which were distributed as loose leaves to his students, and he illustrated his lectures by his own demonstration on the body. Eventually his tables and descriptions were made by him into a book, *De Fabrica Humani Corporis*, which was published at Basle in 1543 (the year of the publication of the *De Revolutionibus Orbium Coelestium* of Copernicus). The former ended the reign of Galen and the latter dethroned the Aristotelian theory of a fixed and immovable world. The *Fabrica* opens with a graphic engraving of a demonstration of anatomy by Vesalius at Padua. The author of the woodcut is unknown, and it is drawn with some licence as to historical fact, but it illustrates so clearly the situation and contains so lifelike a portrait of the professor, that it is not improbable that it was drawn by Calcar. After the appearance of the book Vesalius left Padua (which perhaps he had made too hot for himself), and although he lectured at Bologna and Pisa his career as a professor was at an end. 'My love of knowledge so inflamed me', said Petrarch, 'that my work was retarded by my very desire.'

Subsequently Vesalius became, of all strange things, a Court physician to the Emperor Charles V, made a pilgrimage to Jerusalem, and during his return died on the Island of Zante in 1564, at the early age of 49. But he had lit a candle in Europe, and his five years at Padua had for ever changed the study of anatomy. He had taught his students and all the world that the nature of man was to be learned by direct observation and not on authority, that experiment and its interpretation was the way of observation, and that induction and not deduction was the scientific method. This arresting and dramatic achievement removed the century-old pall of Galenic authority and proved that a knowledge of anatomy was to be vitally acquired.

William Harvey and the Circulation of the Blood

At the present day it is perfectly clear to us all that however great was the work achieved by Vesalius it was but the preparatory foundation of modern physiology.

Vesalius had been dead fourteen years when William

FRONTISPIECE OF THE 'FABRICA'
By courtesy of PROFESSOR SINGER

FRONTISPIECE OF THE 'FABRICA' (VESALIUS DEMONSTRATING AT PADUA)

Harvey was born at Folkestone in 1578, and he arrived at Padua some thirty-four or thirty-six years after Vesalius had left. We do not know why Harvey went to Padua. It was not unusual for Englishmen to go abroad in pursuit of further medical study, in the seventeenth century to Padua or Montpellier and in the eighteenth to Leyden, as they had formerly gone to Florence to attend the Platonic Academy of the Medici. Probably the influence of Caius and his Cambridge College, of which Harvey was a member, combined with the incentive of the Greek learning, took Harvey to Italy.

Fabricius was over 60 years of age when Harvey arrived in 1599 or 1600, and had been professor of anatomy for more than thirty-five years; and Galileo also was at his zenith, the University all alive with his discoveries in astronomy, mechanics, and the properties of matter. It was an inspiring and invigorating place for the young Englishman of 22, and as full of new birth as was Leyden a century later. Harvey no doubt heard much concerning the heart, for both Caesalpinus (who was still alive though he had left Pisa for Rome) and Fabricius were sharing in the great controversy then raging between Galenic and Vesalian doctrines. No doubt Fabricius, at whose feet Harvey sat, discoursed on the valves of the veins. Indeed, Harvey himself tells us as much, and it is more than likely that it was at Padua that Harvey's thoughts first turned to the century-old puzzle of the circulation.

When Harvey returned to London with his M.D. degree from Padua (1602) he settled in practice, married Elizabeth Brown, became a Fellow of the College of Physicians, and in 1609 Physician to St. Bartholomew's Hospital. In 1616, a week before Shakespeare died, he delivered the Lumleian Lectures of the College of Physicians on April 16th, 17th, and 18th, including the subject of the circulation of the blood, and twelve years later appeared his immortal book *De Motu Cordis et Sanguinis* (published at Frankfort-on-Main 1628). Harvey accompanied the Duke of Lennox in his travels in Europe in 1629, as Physician to the King, was in Scotland with Charles I in 1633, and three years later travelled to Vienna with Lord Arundel. You will remember he was also with the King at Edgehill, taking care of the two young Princes, and for the last time accompanied the King at Oxford from 1642 to 1647. While there he acted as Warden

of Merton, Queen Henrietta Maria being accommodated at that college and the King at Christ Church. In 1646 at the age of sixty-eight Harvey retired from the King's service, and lived in retirement with his brothers. He finished and published his book *De Generatione Animalium* in 1651, and died in 1657.

Galen had believed that there were two tides in the blood, a general one and a pulmonary one, or rather that to and from every tissue there was a flow and ebb of two kinds of blood serving a double purpose, one in the veins and one in the arteries. Both contained spirits, a 'natural spirit' derived from the liver, an 'animal spirit' from the brain, and a 'vital spirit' from the lungs. He believed also in the perforation of the apparently imperforate septum between the right and left ventricles, so that there was a partial transit of the blood between the ventricles. Galen also held that the heart was a suction and mixing tank in which the blood was collected and heated, that the veins had no valves, and that the blood-system was an irrigation system. Now, with some slight modifications, this was the generally accepted belief before Harvey's time. It was not merely incorrect, but it stood in the way of any sound conceptions of physiology as a whole. Harvey's observations and experiments led him first definitely to exclude belief in different 'spirits' in the blood, of which there was no evidence; secondly, he found no perforation of the inter-ventricular septum, and therefore no passage of blood could take place through it; thirdly, he knew, what Galen did not know, that the veins had valves which assisted the blood in its return to the heart; and fourthly, he found the heart was a muscular pump propelling the blood to the tissues, the right ventricle to the lung and the left ventricle to the rest of the body, 'and this is the sole and only end of the motion and contraction of the heart'. This is what he says in 'the glorious eighth chapter' of the *De Motu Cordis*:

'When I surveyed my mass of evidence, whether derived from vivisections and my various reflections on them, or from the ventricles of the heart and the vessels that enter into and issue from them, the symmetry and size of these conduits—for nature doing nothing in vain, would never have given them so large a relative size

without a purpose—or from the arrangement and intimate structure of the valves in particular, and of the other parts of the heart in general, with many things besides, I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of the blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might not be *a motion, as it were, in a circle.*

'Now this I afterwards found to be true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large, and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery, and that it then passed through the veins and along the vena cava, and so round to the left ventricle in the manner already indicated. Which motion we may be allowed to call circular. . . .

'The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated the heart of the world; for it is the heart by whose virtue and pulse the blood is moved, perfected, made apt to nourish, and is preserved from corruption and coagulation; it is the household divinity which, discharging its function, nourishes, cherishes, quickens the whole body, and is indeed the foundation of life, the source of all action.'

Whilst this is Harvey's demonstration of the mechanical fact of the circulation of the blood, it possesses much more than its face value, it is much more than a true explanation of the special purpose of the heart and blood-vessels. Harvey's work did much more than explain a mechanical fact. For, first, it introduced the scientific method into a fundamental problem. He showed the necessity of patient and accurate examination of the anatomical morphology in man and animals; he explained the function of these structural facts, as suggested by the particular features of the structure; and he devised experiments, by vivisection or otherwise, for proving the validity of his explanation and interpretation of the function. It was the death-blow

to all fancies, theories, and notions about 'spirits' and 'tides'.

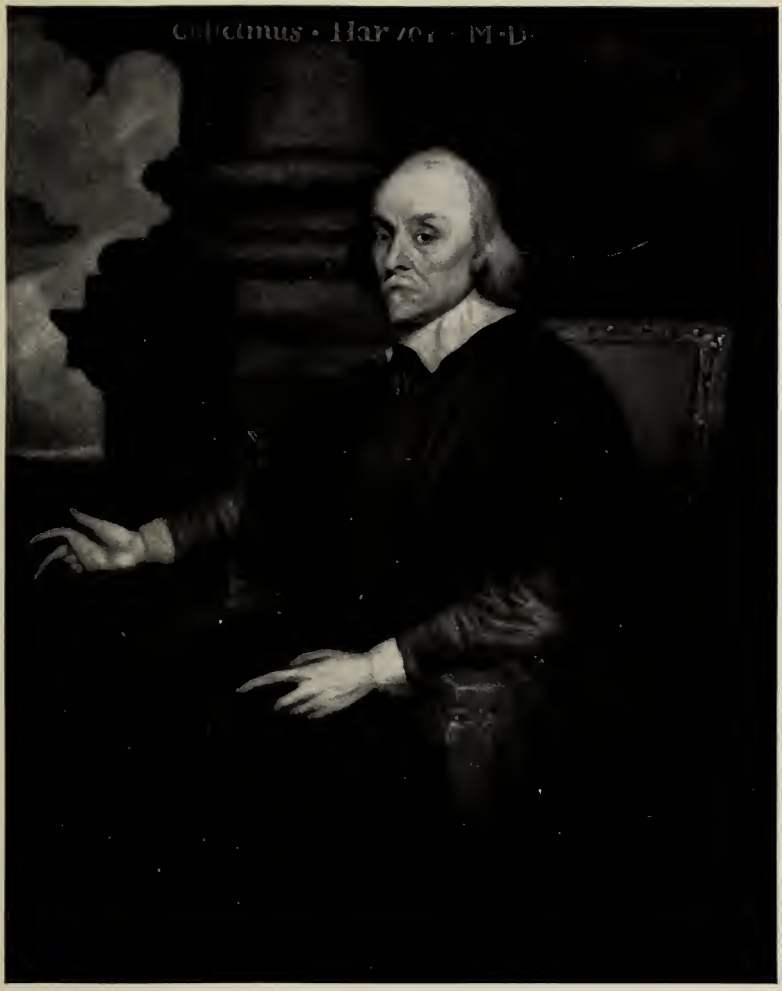
There was a second result, even more important. The discovery of the circulation of the blood opened the door to the intelligent study of the nature of man. The old theories about the circulation blocked the way, and had done so for centuries. The new explanation opened up and made possible new conceptions of the function of the blood itself, its nutritive value, its chemical content, its relation to health and disease. Harvey knew it carried infection.

The New Physiology

Here, therefore, was the beginning of a new time. Men's minds were turned intensively to new problems concerning the nature of the body and to a new method of grappling with such problems. For Harvey's threefold contribution was the demonstration of the circulation of the blood, the import of the blood to man's health and disease, and a scientific method for exploring the problems thus raised. Is it surprising that the results were manifold and of vital concern?

Now hereabouts lies a great deal of truth of essential value in many branches of Preventive Medicine. Harvey's work is revolutionary for us because it made other things possible. Let us see what happened. In 1622 came the discovery of the lacteals and lymphatic system by which nutriment reached the blood (Aselli, Pecquet, and Rudbeck); in 1642 began the series of demonstrations of the ducts of the pancreas, the submaxillary, the parotid, and the kidney; in 1648 began the exploration of the chemistry of digestion; in 1658 came (with the microscope) the discovery of the blood-corpuscles (Swammerdam, Malpighi), and in 1661 Malpighi revealed the capillaries foreseen by Leonardo da Vinci; in 1662 came the first-fruits of the mechanics of physiology (Descartes, Borelli); and by 1668 new light was thrown on the physiology of respiration and the purposes of the aeration of the blood in the lung (Mayow). Numerous advances in the physiology of the circulation followed in the succeeding century, with the discovery of the gases which control life, carbonic acid (1757), nitrogen (1772), oxygen

WILLIAM HARVEY
By courtesy of the ROYAL COLLEGE OF PHYSICIANS



WILLIAM HARVEY

(1774), and hydrogen (1781); in the eighteenth century also there came the beginnings of the new knowledge of the nervous system. The progress of physiology in recent times has been pre-eminent, even in a time of universal scientific advancement. It has been pre-eminent in quantity, quality, and scope. Here we cannot do more than remind ourselves in the briefest possible form, a curtailed inventory, of half a dozen examples of some of the modern advances of physiology which more immediately concern our knowledge and practice of Preventive Medicine. Consider, for instance, the following examples:

(1) *The foundation and development of the cellular theory.* The structure, function, and metabolism of the cell and its component parts—cell formation, secretion, respiration, nutrition, movement, and heat production.

(2) *The dynamics of the circulation and the constant content of the blood.* The chemistry and metabolism of the blood, its rate of flow and pressure, its gases and their exchange, the forms and the normality and abnormality of the blood-corpuscle, the capillaries and the call of the tissues for oxygen, the effect of the blood on the central and peripheral nervous system, the hormones, the bactericidal action of the blood, its alkalinity, the effect of the hygienic life of the individual on the condition of the blood (diet, exercise, fresh air, altitude, &c.).

(3) *The biochemistry of nutrition, digestion, and assimilation.* From the essential organs and their functions (lacteals, lymphatics, secretory glands) we have passed through fermentation and Helmont's 'six digestions' to the whole problem of metabolism and its measurement and control, and the functioning of liver, spleen, pancreas, and kidney. The part which a chemical and vitamin dietary takes in assimilation and nutrition.

(4) *Nervous Regulation and Integration.* The structure and function of the central and peripheral nervous system, motor and sensory, brain centres and spinal centres, localization, regulation, and integration, their

physical and chemical interdependence, reflex action, sensation, volition, correlation.

(5) *Muscle and its nervous control.* From Borelli onwards the function of voluntary and involuntary muscular structure has developed; its chemistry, physics, and neurology.

(6) *Endocrinology.* The regulation of the body functions by secretions of the ductless glands (hormones), as well as by the nervous system: the suprarenals, thyroid, parathyroids, pituitary body, testis and ovary, thymus. Insulin from the pancreas (diabetes), thyroxin (myxoedema), liver extract (pernicious anaemia).

(7) *The physiology of Respiration.* Founded upon Malpighi's work on the structure of the lung, and that of Borelli, Boyle, Hooke, Lower, and Mayow on the function of air in the lung, came the discovery of the part played by the four essential gases, followed by exploration of their effects in haemoglobin, blood and tissue respiration.

As you will appreciate, these are but illustrations of the wide field of physiology. You will also appreciate the impossibility of following them up here and learning what developments have taken place, or whither they all tend. Indeed we have only space to refer briefly to one of them, namely, nutrition. Until recently nutrition stood for food, and effective food consisted of certain chemical constituents (protein, carbohydrate, fat, minerals), and supplied daily substance of recognized calorie value. Now we know that nutrition is a complex syndrome, which though it includes food is also dependent upon body metabolism, oxygenation of the tissues, body temperature, muscular activity, secretory and excretory response, and assimilation. In recent years research has shown that nutritive food must also contain vital accessory substances, provisionally named vitamins. Eykman found in 1897 that polyneuritis of birds is due to the lack of some such substances, further explored by Funk in 1911; in that same year other investigators found that beri-beri could be cured by feeding with the cortical layers of rice; and yet others, including Hopkins, Stepp, Osborne, and the Mellanbys, had observed that deficiency was produced in mice, rats, and puppies if their food, however ideal in other respects, was made to exclude such accessory substances. From these beginnings much was to emerge, and by the researches of these and other workers a group of these essential

substances has been isolated. No doubt current investigations will elucidate many obscurities and uncertainties, but a new chapter has been opened. We now know that cod-liver oil, milk, egg-yolk, and certain animal fats contain a vitamin (A) upon which growth is dependent, and which favours body resistance to infection contracted through mucous membranes; another vitamin (D) is essential to the formation of bone and teeth, and the absence of it may induce rickets; whilst green leaves, fresh vegetables, and certain fruits (lettuce, cabbage, oranges, and lemons) contain a vitamin (C) which prevents scurvy; and again, cereals (unpolished rice), pulses, yeast, contain a vitamin (B) which contributes to nervous stability and prevents beri-beri. Here, therefore, we have a new departure in nutrition standards, which may well prove invaluable both in the choice of dietaries and in direct prevention of certain diseases. It throws an interesting light on the rationale of Lind's prevention of scurvy by fruit juices in the eighteenth century.

The mere mention of these seven outstanding advances, in brief category, displays the vast scope and bewildering character of the new physiology, directly or indirectly made available by the opening of the gates by Harvey. Obviously, its formulation was not designed by him; it was constructed out of physics, chemistry, biochemistry, biology, anatomy, pharmacology, as well as physiology. Here is an analytic and a synthetic physiology, as a fundamental science of itself and as the basis of Medicine. It is also the foundation of Preventive Medicine, the aspect of the whole with which we are concerned. Be most certainly assured that *these* things, and not merely drains and disinfectants, are the data with which Preventive Medicine has got to deal.

How far away we here seem to be from 'humours' and 'spirits', even from 'protoplasm'. Can we here find the 'some grand purpose' which Borelli sought? Can we conceive of a common denominator, a synthesis, an integration, in these complex and varied parts of the whole?

The Synthetic Harmony of Claude Bernard

When the young and amazing Bichat witnessed the rising tide of physiological knowledge at the very opening of the nineteenth century he urged men to see 'the sum of the forces that resist death'. He had attempted a synthesis

expressed in the tissue rather than the cell, and assigning special vital properties to particular tissues he conceived the idea of a total synthesis. The time was not ripe, nor is it ripe yet, for this. Yet something can be done. As the result of his work in 1848 on glycogen, Claude Bernard, the greatest physiologist of modern France, published his *Leçons sur les phénomènes de la vie* in which he argued that there were three forms of life, a *vie latente*, where life is not evident, a *vie oscillante*, where evidences of life are variable and dependent on external environment, a *milieu extérieur*, and thirdly, a *vie constante*, independent of external environment and indifferent to its changes because possessing a *milieu intérieur* which remains constant. This is what he says:

'I think I was the first to urge the belief that animals have really two environments: a *milieu extérieur* in which the organism is situated, and a *milieu intérieur* in which the tissue elements live. The living organism does not really exist in the *milieu extérieur* (the atmosphere if it breathes, salt or fresh water if that is its element) but in the liquid *milieu intérieur* formed by the circulating organic liquid which surrounds and bathes all the tissue elements; this is the lymph or plasma, the liquid part of the blood which, in the higher animals, is diffused through the tissues and forms the ensemble of the intercellular liquids and is the basis of all local nutrition and the common factor of all elementary exchanges. A complex organism should be looked upon as an assemblage of simple organisms which are the anatomical elements that live in the liquid *milieu intérieur*.

'The stability of the *milieu intérieur* is the primary condition for freedom and independence of existence; the mechanism which allows of this is that which ensures in the *milieu intérieur* the maintenance of all the conditions necessary to the life of the elements. From this we know that there can be no freedom or independence of existence for simple organisms whose constituent parts are in direct contact with their cosmic environment, and that this form of life is, in fact, the exclusive possession of organisms which have attained the highest state of complexity or organic differentiation.

'Stability of environment implies an organism so perfect that it can continually compensate for and counterbalance external variations. Consequently, far from higher animals being indifferent to their surroundings, they are on the contrary in close and intimate relation to it, so that their equilibrium is the result of compensation established as continually and as exactly as if by a very sensitive balance

'The necessary conditions for the life of the elements which must be brought together and kept up constantly in the *milieu intérieur* if freedom and independence of existence are to be maintained are already known to us: water, oxygen, heat, and reserve chemical substances.'

Writing at an earlier period on experimental medicine Bernard said that, 'physiologists and physicians gain mastery over the phenomena of life by learning which conditions in the inner environment are normal and which abnormal. . . . It is in the study of these inner organic conditions that direct and true explanations are to be found for health, sickness, and death.' Bernard himself found an example of this constancy of the internal environment in the maintenance of the proportion of the sugar in the blood as regulated by the liver, a balance between activities which disturb and activities which restore. But modern physiology has greatly increased the evidential illustrations of this balance, e.g. there is the relatively constant blood content (even in transfusion), the constancy of respiration, of body temperature, of antagonistic nerves, of renal secretion, of alkalinity of blood, of integrative adaptation, of endocrine secretion (hormones) and of metabolism and substantial reserve.

The explanation does not lie in the external environment, for that, within limits, is *variable*. Heat and cold, muscular activity and fatigue, light, sound, and other sensory stimuli, and the deficiency or excess in food and drink exert their stimulant or depressant effect upon the body. It is the social external environment against which man has to defend himself or regulate, though even here the constant internal environment is his surest defence. I have already mentioned the formidable assault of blood transfusion, which is compensated; there is also infection and contagion, poisons of widening variety, exposure, persistent fatigue, traumatisms. The answer to some is a natural or acquired immunity, and to others the powers of resistance, repair, and restoration—blood coagulates, exuded material is absorbed, functionally abnormal tissues and nerves return to normal, and hormones control. The body adapts itself, for it is its total *life*, and not the chemistry and physics of its parts, which constitute resistance.

Whilst we lack the basis for anything in the nature of a complete physiological synthesis, we have in Bernard's conception—often forgotten by the individual experimental physiologist whose work is nevertheless confirmatory of it—a working principle of great practical value in the practice of Preventive Medicine. It is the synthetic interpretation of 'the *conservation of health*' (Bernard). It is here we must begin our outlook upon, and our appreciation of, the nature of Man. It is here alone we can understand either the true inwardness of Conservative Medicine or the true purposes of Preventive Medicine. It is the keyboard and compass not alone of the principles of the prevention of disease or its sequelae, but of the maintenance of *health*, the physiological balance and harmony. The body possesses its own internal and inherent defences (cellular and chemical) to maintain the constancy of its internal environment. These must be protected, developed, and fortified if we are to increase its capacity and powers of resistance.

Yet, as we have seen, the body is not alone, isolated by itself. It is a part of Nature, and, as we all know, surrounded by a variable environment, favourable or unfavourable to its survival, growth, and resistance. 'Perfect correspondence with environment would be', as Herbert Spencer said, 'perfect life'—and he defined life as 'the continuous adjustment of internal relations to external relations'. Claude Bernard claimed that, in order 'to conserve health and to cure disease' the fundamental synthesis which is necessary is a balance, a harmony, between the constant internal environment of man's body and the variable external environment which surrounds it. We must seek to conserve that internal environment as we must seek to control the external environment. We must learn how to discover, create, and maintain a favourable external environment, and we must then habituate and train the body to respond to it. Any departure from such a balance is disharmony, the beginning of disease. Disease is the reaction of the body to irregularities in its internal or external environments. Metchnikoff said disease was a disharmony and it has been described as 'the dissociation of the functional unity of the

body'. The chief business of Conservative or Preventive Medicine is to apprehend the true nature of Man and his environment, to learn how to strengthen and use the constant internal environment (physical and mental) and control the variabilities of the external environment, and thus establish and maintain harmony between them.

This is the lesson which Preventive Medicine must learn from Physiology, and it is instructive as well as encouraging for us to be the witnesses of the advance which has been made in our day and generation in the appreciation of this fact not only by the expositors of Preventive Medicine but by civil and imperial government. Our necessity in the European war proved this on a large and even dramatic scale—immunization against infection, the surgery of wounds, nutritional defences against starvation, the treatment of fatigue and shock, the health of the munition worker, the prevention of industrial poisoning, the safeguarding of the soldier in aeroplane or submarine, the protection against gas warfare, the clothing and diet of soldier and civilian, are instances of such official action. But ever since the public medical services were established for army, navy, or the civil population there has been increasing appreciation of the application of the growing facts of physiology to the conservation of health and the prevention of disease.

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VII

CLINICAL STUDIES OF COMMUNAL DISEASE

Synopsis of Lecture VII

Clinical studies and preventive measures necessary in addition to reliance on the internal environment of the body.

The remarkable contribution of the English medical practitioner to the underlying principles of Preventive Medicine.

The clinical experience of the seventeenth century.

Sydenham and his epidemic constitutions (1624–89). The practical lessons of the Plague and 'the new era of epidemics' (typhus, influenza, sweat, and gaol fever). The work of Sydenham.

Some particular preventive studies in the eighteenth century.

(1) Ramazzini on Occupations (1700). Percival Owen, Aikin.
(2) Alcoholism in England, 1720–50. The Gin Acts.
(3) Mead, 1720; Fothergill, 1747; Huxham, 1755; Haygarth, 1775; Heberden, 1802, on Infective Diseases.
(4) Domestic Hygiene and Child Welfare—Fothergill, Lettsom, Cadogan, Willan.
(5) Pringle (1752) on Diseases in the Army. Lessons of war.
(6) Lind on prevention of Scurvy (1753) and health of seamen (1774).
(7) Blane on Diseases of Seamen (1785). The great voyages. Vasco da Gama, Magellan, and Cartier; Drake and Hawkins; East Indies; Anson; Captain Cook.
(8) Baker on prevention of Lead Colic (1767).
(9) Prevention of Puerperal Sepsis—Smellie, William Hunter, and White.
(10) Jenner, 1798. Inoculation and vaccination. John Hunter on surgical pathology and the recuperative powers of the body. '*Don't think, but try; be patient, be accurate*'—(Hunter to Jenner).

VII

CLINICAL STUDIES OF COMMUNAL DISEASE

When one looks at an English medical chronology of the last four hundred years, say, from the return of Linacre from Italy or from the age of Leonardo da Vinci, one finds oneself the witness of an astounding wealth of new endeavour. There were the anatomists, naturalists, physicists, and herbalists—Banckes, Turner, and Gerrard—in the sixteenth century, followed by Harvey and the clinicians—Glisson, Mayerne, and Sydenham—in the seventeenth century. Mayerne was the prominent physician and pharmacologist of his day, Glisson the morbid anatomist who first described rickets, and Sydenham the first of the epidemiologists. Then in the eighteenth century came a succession of clinical practitioners—Mead, Floyer, Sloane, Fothergill, Lettsom, Cheselden, Huxham, Heberden, Haygarth, Hewson, a group of obstetricians, the Hunters, Pringle, Pott, Withering, Blane, Baker, Baillie, and Jenner. And every man of them left a mark on English Medicine, and, as we shall see, laid the clinical basis of Preventive Medicine. Harvey was a long-distance pioneer, whose harvest is even yet not fully garnered, but some of the others obtained fame in their lifetime, the work of their hands, in ancient phrase, 'being established upon them'. The eighteenth century is a very rich period for us, and demonstrates beyond doubt the wonderful contribution made by the practitioner to the advance of Medicine.

Here are eight things which we have from the hands of the English medical practitioners of the eighteenth century. And we may make an inventory of them at once:—

(1) *They explored the circumstances of epidemic disease in their day*, which because of a widening world were various and interrelated. They observed the clinical features, the causative relation of external environment, the channels of contagion and infection, and the effect of climate and season. Their great prototype was Thomas Sydenham, the London practitioner, who flourished in the previous

century. In his time ague, plague, influenza, and small-pox were prevalent, with 'fevers' of many degrees. Hysteria, gout, dropsy, skin disease, and 'biliousness' also abounded, and of some of these he left us full description. There followed more or less in his footsteps the eighteenth-century group. Huxham of Totnes studied typhoid, typhus, scurvy, and diphtheria; Richard Mead, plague and scurvy; the illustrious Heberden, diphtheria, angina, chicken-pox, night-blindness, small-pox, measles, and 'epidemical colds'; Fothergill, epidemic sore throat; Haygarth of Chester, small-pox, typhus, and rheumatic fever; Willis, epidemic diphtheria, typhoid, and puerperal fever; and Withering of Shropshire, scarlet fever, heart disease, and tuberculosis. All these observers also pursued the seasonal and constitutional theories of Sydenham. Never before had there been such a recording of the clinical characters of epidemic disease as by these 'annalists'. They were men of outstanding position and represented a hundred others scattered about the country, who were likewise engaged in the close study of the ways of disease, how disease arose, how it could be diagnosed and differentiated, how treated and prevented. Their diaries and commentaries are full of clinical notes, suggestions, theories, and notions. Haygarth worked in Chester, and in later life at Bath. He enumerated the population of Chester in order to gauge the incidence of disease; he compared disease of one village with another; he considered the insusceptibility of those who escaped infection, and measured its periods of incubation. Huxham had been trained under Boerhaave at Leyden, and when he settled in practice at Plymouth he commenced a systematic study of disease in relation to season, of the use of antimony, and, taking Nature for his guide, he treated disease on rational principles. His *Observations* (1739–52) and his *Essay on Fevers* are marked by minute and careful clinical work and cautious induction. Heberden was described by Dr. Johnson as 'the last of the great physicians', and his famous commentaries published after his death in 1801 became a classic among clinical records.

(2) They introduced *medical methods* of notification, of

isolation of infectious persons from the community in 'houses of recovery' or otherwise, of fumigation and disinfection. Mead, who had been called in by 'the lords of the regency' in 1719, advised the Government as to the methods to be adopted to prevent the spread of plague. His book, published in 1720, ran through seven editions in one year. It is of historical interest as being the first report of epidemiological advice produced by a medical practitioner at the request of the State (though not the first appeal from Government to the profession). Mead recommended the appointment of a Council of Health with plenary powers, of 'searchers' for the dead, and of 'skilled physicians' to attend the sick. He advocated official certification of affected persons, the prompt isolation of the sick, the disinfection of persons and houses. 'The principal management of this whole affair [of preventing the spread of plague] consisteth', he says, 'of two things: (1) in separating the sick from the sound, and (2) in cleaning well the houses which had been infected.' Sixty years later Haygarth carried out rules of this sort in Chester, and in 1839 Dr. Farr began the national organization of the registration of sickness and death, which under the Registrar-General proved one of the foundations of English public health administration.

(3) They began the *reformation of midwifery*, by becoming obstetricians themselves, by improving the methods of delivery and the care of the lying-in woman, and by the introduction of antenatal care. To this matter I will refer again.

(4) They first attacked systematically the *high infant and child mortality*, which was unfortunately a characteristic of the first half of the eighteenth century. There was not at that time the same completeness of registration as in recent years, but Dr. William Farr in his official report of 1876 quotes the table of child mortality given on the next page. From these figures it is evident that from 1730 to the beginning of the nineteenth century the medical practitioners were faced with the problem of an appalling loss of life in infancy and early childhood. Lettsom, Cadogan, and other practitioners did much to draw public attention to

Births and deaths under 5 years of age, according to the London Bills of Mortality, for 100 years in five periods of 20 years each, and the number dying under 5 years out of 100 born. (*Compare 1915–24.*)

London.	1730–49	1750–69	1770–89	1790–1809	1810–29	1915–24 (England and Wales)
Total births	315,456	307,395	349,477	386,393	477,910	927,473
Total deaths under 5 years	235,087	193,694	180,058	159,571	151,794	128,739
Dying per cent. under 5 years	74·5	63·0	51·5	41·3	31·8	13·8

domestic insanitation and to the necessity of what is now called 'infant welfare'. They established 'infant dispensaries' and issued advice on infant management. It was the beginning of a movement which reduced child mortality from 74 per cent. of children born in 1730–49 to about 10 per cent. to-day.

(5) They advocated *an improved and extended dietary* (including tea, coffee, vegetables, and fruit) combined with restriction or abolition of spirit drinking. The fact is that between 1720 and 1750 there was in England a great set-back in the public health, and the number of deaths greatly exceeded the births. This has been attributed largely to the orgy of spirit drinking which characterized the period. Gin became, in fact, 'the real grand destroyer'. Distilling was a new trade in England, and as it provided a revenue for the State and at the same time gave the farmer a favourable market for cereals, it received widespread support from the landed interest, from the distiller and retailer, and from the consumer. Accordingly, Parliament itself promoted the production and consumption of spirits. In a few years the results became so disastrous that the College of Physicians and numerous grand juries and sessions petitioned Parliament to impose restrictions. The number of pot-houses increased to such an extent that there was one to every six houses and every forty-seven persons. In 1750, London physicians directly attributed 14,000 cases of illness in the Metropolis to the excessive drinking of gin. Hogarth

illustrated the results in his representation of 'Gin Lane', and Smollett described the situation as 'a shameful degree of profligacy'.

An Inland Revenue officer (Scarisbrick), writing of this period says that 'drunkenness abounded. By 1720 we had become a nation of tipplers. The nobility patronized brandy, the well-to-do middle classes drank a newly-introduced spirit called rum; the working-classes imbibed a characteristic spirit known as British gin. The consumption of gin was enormous.' When certain restrictions which had been temporarily imposed were repealed in 1733, he says, 'England touched a lower depth of inebriety than ever known before or seen since. The prevailing intemperance was the most momentous event of the eighteenth century.'

With a view to meeting the problem thus created, Parliament passed a series of Gin Acts. In 1736 it imposed a high duty on spirits and a high tax on licences. Though at first this effected some reduction, things soon became worse than before, and maximum sale and consumption occurred about 1743. After various abortive measures, the Acts of 1751 and 1752 took effect. They aimed at the suppression of gin shops and private retail sales. Lecky held that these measures were efficacious, but even at the end of the century Dr. Willan wrote that 'on comparing my own observations with the Bills of Mortality, I am convinced that considerably more than one-eighth of all the deaths that take place in persons above twenty years old, happen prematurely through excess in spirit drinking'. In addition to legislative action, the scientific evidence against the excessive consumption of alcohol was presented by Dr. Cadogan, Dr. Trotter, and other medical men, and the public-spirited action of Wilberforce and his friends created a more enlightened opinion and healthier habits among the people. Dr. Cadogan's book on gout is perhaps the most remarkable preventive treatise on the evils of intemperance that appeared in the eighteenth century. It passed through ten editions in two years. Compare this pioneering effort for the prevention of alcoholism with modern methods of the Liquor Control Board of 1915-18 and the recent

Royal Commission on Licensing, and consider the relation of the increased sobriety of the nation and its health.

(6) They initiated *industrial welfare* and were the primary movers in health and the sanitary control of the factory system. The Industrial Revolution which began in the last half of the eighteenth century led to the movement of the people from the rural districts to the towns and from the fields to the mills. It led also to the employment for long hours in the mills of the 'apprentice' children. Impaired physique and epidemic disease followed, and Percival and Ferriar of Manchester set to work to explore the situation. That was the beginning of a far-reaching national service. They found excessive hours of labour, unwholesome conditions, and insanitation fostering the spread of infectious disease. They found young children enslaved in a system which was directly harmful to body and mind. These facts were brought before a voluntary Board of Health which they and their friends had devised in 1796, with the result that the question of factory hygiene and regulation by law was brought to the attention both of the authorities in Manchester and the Imperial Parliament in London. Some years afterwards Sir Robert Peel acknowledged his indebtedness to Percival and his associates in the preparation of the Health and Morals of Apprentices Act of 1802, the first of that great stream of factory laws the influence of which has revolutionized health in industry throughout the world.

(7) They lent their support and service to the *establishment of dispensaries*, hospitals, and medical schools.

(8) They laid the early foundations of *acquired immunity*, first by inoculation and then by vaccination against smallpox. Of some of these matters I shall speak later, but first we must understand in a general way the service rendered by Thomas Sydenham, and why he came to be called the Father of English Medicine.

Thomas Sydenham

It was Sydenham who, strangely enough as some suppose, became the backbone man of English Medicine in the seventeenth and eighteenth centuries. He was a reformer

of medical practice and the chief interpreter in the England of his day of the principles and doctrines of Hippocrates, for he introduced the Greek outlook.

This sturdy Puritan, who could not be bent and would not comply with the conventions of a bygone day, belonged to Dorsetshire. He was born in 1624 at Wynford Eagle, a pleasant old manor house near Dorchester, Hardy's Casterbridge, the son of a Puritan family which had lived there for generations. In 1642 he was sent to Magdalen Hall (afterwards Hertford College), Oxford, the College of Tyndale the translator of the Bible, of Sir Matthew Hale the lawyer, Sir Harry Vane of Cromwell's army, and of Hobbes the philosopher, and the work of these men left a mark upon him. He enlisted in the Parliamentary army, but on the advice of a friendly physician, Dr. Coxe, returned to Wadham and entered on medical study, and like Linacre was associated with All Souls. He remained at Oxford for some seven or eight years, studied Greek, and became friendly with distinguished men who changed the course of his life. There was Sir Thomas Clayton the Regius Professor of Medicine and Sir Thomas Millington, afterwards President of the Royal College of Physicians; Dr. Petty the economist; Cromwell's physician, Dr. Goddard, the Warden of Merton after Harvey; Christopher Wren; then there were Willis and Richard Lower, both medical investigators, who afterwards practised in London; and lastly, there were two outstanding philosophers, the Hon. Robert Boyle and John Locke—these were the contemporaries of Sydenham and influenced his growing mind.

When Sydenham left Oxford he married Mary Gee of Wynford Eagle, and settled in King Street, Westminster, near where the Ministry of Health now stands. Ten years later he moved to a more salubrious part in Pall Mall, but before doing so he went to Montpellier, and there learned from Barbeyrac, the practitioner-teacher who taught clinical medicine in the University hospital. Barbeyrac probably trained Sydenham in exact clinical method, in the use of few drugs, and in careful observation and examination of the patient. I must not speak in detail of Montpellier,

except to say that it was Arabic in foundation at Maguelone and dated from the eighth or ninth century, re-established at Montpellier in 1180. Many of the famous 'Arabian' physicians practised and taught there, and it is believed that Locke himself attended the University. However that may be, the Montpellier atmosphere stimulated both Locke and Sydenham, and when the latter returned to London he was determined to practise Medicine on particular lines, namely, to observe disease exactly and build up the medical history of each patient, to try experimentally forms of treatment which depended on the natural powers of the patient, and to discover preventive remedies. Thus he became known as the physician who recommended horse-back exercise, living in the open air, simple dietary, canary wine, mild purging and less bleeding, rest and sleep. Yet these vagaries of practice were not Sydenham's contribution to Medicine, they were merely incidental. He wrote a series of little books, some of them hardly more than letters to his medical friends, and it is these small books which made his fame.

Sydenham had been in practice only half a dozen years when he produced, in the forty-second year of his age, his first book. It was a small octavo volume of 156 pages on continued and intermittent fevers, plague, and small-pox. In 1676 a third edition came out, entitled *Observationes Medicae*, which became his most famous work, and described the fevers of London from 1661 to 1675. It is from this book, and the other precious little old-world volumes which followed it, that we glean our fragmentary knowledge of the life and thoughts of the great physician. From their pages alone can we now learn who were his friends, who his heroes, and what manner of man he was; what were his aims and hopes; and what the deep springs of his purpose.

The prevalent fevers of the time were studied by Sydenham and his contemporaries, but he re-interpreted the Hippocratic conception of epidemics, and in such a way as to lay the foundations of modern epidemiology. Here, as in his general practice, he sought to return to Nature,

observing and collecting facts upon which to build principles. Let us consider in simple terms what he says in this little book. (*a*) Certain fevers, he saw, had an epidemic character, which bred true; and the features of such outbreaks followed a type year after year; they were, in fact, 'regular and uniform, with the same phenomena and a general conformity of symptoms'. Then he saw also (*b*) that there were *variations*, 'Nature playing tricks'—the same disease, as he believed, manifesting itself with various dissimilar aspects as to origin, formation, decline, 'like a monarch with a bodyguard of foreigners'. In a word, there were phases and affinities, modifications and varieties. His next observation was (*c*) that both typical and atypical fevers prevailed at certain times, dependent, he thought, upon meteorological or atmospheric conditions, or other external influences. He began to feel out after the idea of *contagion*, though not very surely. As he disregarded the progress of physiology, so, in fevers, he seemed oblivious of the advance which had taken place in the conception of contagion and infection. However that may be, he saw (*d*) that when several fevers infested the same period one of them had an ascendency over the others. When the paramount complaint increased they declined, when it lost ground they increased. The disease or symptoms which predominated determined the 'epidemic constitution' of that season, and thus there were different epidemic constitutions in different periods, with a counterpart seasonal predisposition in the human constitution. Lastly, he saw (*e*) that some epidemic constitutions were secular in length, long-period, and others were short and seasonal. Here is his table for the years of this particular study of London fevers:

1. 1661–4. Intermittent fevers predominated and continued fever.
2. 1665–6. Plague predominant.
3. 1667–9. Small-pox 'constitution'.
4. 1669–72. Dysentery and cholera, with continued fever and measles.
5. 1673–6. Comatose fevers and influenza.
6. 1678–80. Return of intermittent 'constitution'.

Such are the five principal points in Sydenham's Doctrine of Epidemics. They accord with the epidemics of Hippocrates in the island of Thasos in the fifth century B.C. Yet Sydenham not only re-interpreted Hippocrates, but independently defined the purpose of fever (as Nature's way of expelling 'morbific humours' from the body); studied the actual signs and symptoms, the natural history, of the disease; attempted to differentiate the various fevers and allocate causes of their becoming epidemic; and showed that the decline of an epidemic constitution was followed by secondary and variant maladies referable, as he believed, to a common cause. All the way through the book he discourses of the characteristics of each of his five groups and sprinkles his pages with medical advice and prescriptions. Much of his therapeutics is now obsolete, but this book won for him the title of the 'English Hippocrates', and it gave, once and for all, a peculiar and distinctive Coan quality to English Medicine.

Sydenham's other little books were letters to his friends. Dr. Robert Brady, the Master of Caius, the Regius Professor at Cambridge, a Royalist and physician to the king, asked him about the use of quinine and the treatment of rheumatism. Another letter came about the same time from Lambeth Palace, from Dr. Henry Paman, companion to Archbishop Sancroft and Public Orator at Cambridge, who wrote complaining of the ineffective treatment of venereal disease by 'quacks, barber-surgeons, and mountebanks', and he begged Sydenham to 'send something' on this subject. Sydenham replied to both these correspondents, and published his letters in 1680 under the title *Epistolae Responsoriae*. Another letter on gout and dropsy was addressed to Dr. Thomas Short, a Roman Catholic professional friend who, in stormy days, had defended Sydenham. Sydenham was himself for thirty years the victim of gout, and evidently wrote his reply from personal experience. The masterly description of gout given in this little book (*Tractatus de Podagra*) of 1685 is, in some ways, the most suggestive and realistic picture of that disease to be found in medical literature. Sydenham knew he had written

something worthy, and on the title-page he placed a favourite motto from Bacon: 'We have not to imagine, or to think out, *but to find out*, what Nature does or produces.' As Dr. Payne says, no words could more truly express Sydenham's own method.

In 1686 Sydenham brought out *Schedula Monitoria*, the last medical work published in his lifetime, a supplement to his Medical Observations dealing with a 'new' fever, and recording some later thoughts on cholera, hysteria, and calculus. Though Sydenham says this book concludes all he had to say, it was not the last from his hand, for in his later years he compiled a summary of his methods of treatment for the use of his son. This tiny volume, *Processus Integri*, issued after his death, was sold in many thousands in various editions in England and abroad. It names *seriatim* sixty-one morbid conditions, with advice as to treatment and prescriptions. It became the guide and companion of English practitioners for more than a century, and gave Sydenham a unique place in his profession.

Sydenham died on December 29th, 1689, at his house in Pall Mall, and three days later his body was laid to rest near the south door of St. James's Church, Piccadilly. And one hundred and twenty years afterwards the College of Physicians, which did not, in his lifetime, receive him into its full fellowship, wrote above his grave, 'Medicus in omne aevum nobilis'.

The Work of Sydenham

Other physicians were writing at this time, but Sydenham's medical writings differed from those of his contemporaries —Glisson, Wharton, Willis, Morton, Richard Lower, and Mayow—in certain particulars and in the emphasis laid upon particular issues. For instance, he gives priority to the direct clinical observation of the patient before him; for him, that carries a paramount supremacy over all else. Every patient is dealt with as a sample of natural history; not morbid anatomy, not arguments drawn from autopsy, so much as what the body of the living patient reveals or declares. Again, he is free from the current thraldom of the

time, such as the 'days' of occurrence, or the rising or setting of stars, or what the 'tradition' was respecting such and such signs or symptoms. His mind is on what is actually there, why it is there, and what will remedy the defect. It was this that led him to be vigilant for instances of his 'epidemic constitutions', to examine them closely, to appreciate the facts they disclosed. He was analytic and comparative in mental appreciation, no doubt sometimes seeing that which was not, or over-pressing its analogies. But step by step he sought to build up 'laws' of diagnosis of disease and of forms of treatment. Looking back some may surmise that Sydenham pursued his 'epidemic constitution' and 'cycles' too far, but they proved an invaluable incentive to inquiry and to the wisdom of perceiving a possible common denominator to the varying manifestations of disease rather than the prompt acceptance of differences as indicating 'a new disease'. Nor can it be doubted that modern knowledge has confirmed and fulfilled much of his foresight.

Though surrounded with other kindred spirits Sydenham does not appear to have co-operated with them much except by correspondence. He walked alone and had few immediate disciples. He was not a Fellow of the College of Physicians, does not refer to Harvey's demonstration of the circulation (published when he was a child of 4), and did not apparently appreciate the great current labours of Glisson and Willis on pathology, of Mayow and Lower on the respiration, or of Descartes and Kircher on contagion. But his time came sure enough, and within two generations his books and methods became almost universal.

As Harvey had inaugurated the experimental method in physiology, so Sydenham *revived the Hippocratic doctrine of the study of the natural history of infective disorders.* Eighteenth-century Medicine followed his lead from its dawn to its setting, but its inquiries were even more analytic, more co-operative, more widely varied in scope, and much more imbued with the idea of immunization. It must be added that some of the annalists diverged from Sydenham in the differentiation of fevers, and such diagnostic separation led to a preference for 'entities' where Sydenham would have

seen association or mutual relation. The same divergence from Sydenham may be witnessed to-day. The controversy is not ended, though the enormous advance in the knowledge of the germ specificity of infective processes and of their correlation with the new facts of pathology have greatly relieved its turbulence.

Further, on the one hand, the brilliant field-work of the nineteenth-century investigations (initiated by the work of Dr. Snow in cholera) gave prominence to the influence of environmental factors such as soil, water, and food as channels or means of infection; and, on the other, there arose a tendency to emphasize the seed too much and the soil in which it is sown too little. There has also perhaps been insufficient regard paid to the internal constant environment of the body, its natural susceptibility or its natural immunity, as there may have been undue credulity in regard to the specificity and immutability of pathogenic bacteria. There are endless discussions, now as formerly, without any profound difference as to the fact of the interplay of all these factors, though now one and now the other has received emphasis. Again, the inquiries and experience of a general nature have been impressive. They may have dislodged Sydenham from some of his former defences, but they have not belittled his wide-sweeping reflections nor removed the fact that the varying manifestations of infective processes have their 'setting' or constitution and even their cycles. We still recognize, and are puzzled by, the protean and pandemic characteristics of influenza, the changing incidence and severity of variola, the features of epidemic nervous diseases, or the prevalence and intractability of the protozoal infections. We have, moreover, new knowledge of filter-passers, 'carriers' and invisible droplet infections which did not embarrass Sydenham, as we have the added experience of testing universals by particulars, of checking notifications, and of the study of immunity defences. We are indeed living in a period of amazing collection of data in regard to herd-infection and herd-immunity, and are finding that our ignorance is always greater than our knowledge, and that endless analysis and artificial conditions

may mislead us. We must not be disappointed if we cannot yet reach the secure and synthetic generalizations we seek and have all too often to accept provisionally a balance of probabilities.

I propose now to mention to you five pioneering examples of the eighteenth century which demonstrate the work of medical practitioners in regard to the direct prevention of disease and premature mortality. Each of the five not only illustrates the forward-looking work of the time, but each became the basis of modern methods of Preventive Medicine on a far-reaching scale.

I. *The Prevention of Puerperal Sepsis*

The high death-rate in childbirth which was occurring at the end of the seventeenth and the beginning of the eighteenth centuries drew professional attention to the importance and indeed the urgency of reform in midwifery. But a substantial contribution had been made to such reform long before. It came from unexpected quarters. For first William Harvey in his retirement in 1651 produced his great book *De Generatione Animalium*, in which he discussed the anatomy and physiology of the foetus and the necessity of occasional medical intervention in childbirth. It is unnecessary to say that his sense of reliance on Nature made him conservative regarding ignorant haste of the midwives, in whose hands delivery had long rested. 'The younger, more giddy and officious midwives, who mightily bestir themselves and provoke the expulsive faculty and who, persuading poor women to their three-legged stool before the time, do weary them out and bring them in danger of their lives.' He saw that their safety depended on a new understanding of the mechanism of accouchement.

At an early date Peter Chamberlen, a barber-surgeon, had invented the obstetric forceps, an invention which he and his family kept secret certainly for a century, for it was not described or its use advocated in this country until the first quarter of the eighteenth century. Dr. John Mawbray and Mr. Edmund Chapman were pioneers in the

use of the forceps in general practice, and the former was the first to emphasize the necessity of the 'man-midwife' paying regard to antenatal supervision, and probably the first to suggest an organized lying-in hospital, the actual establishment of which was reached by Sir Richard Manningham in 1739. 'In France', says Mawbray, 'men only profess this business; in Italy and Germany men and women promiscuously; in England and Scotland men are styled "extraordinary midwives", being seldom or never called but in extraordinary cases of difficult and preternatural births.'

The subject was greatly advanced by William Smellie and William Hunter, two Lanarkshire men, who became leaders in obstetrics in London. Smellie was the elder. In 1741, when William Hunter came to London, he stayed at the apothecary's shop of William Smellie in Pall Mall. Like himself, William Smellie was an active young Scotsman from Lanarkshire, who, after wandering on the Continent, devoted himself to obstetric practice in London, where he soon filled a pre-eminent position. He was the friend and teacher of Tobias Smollett, learned his midwifery in Paris, and settled in London in 1739 as practitioner and teacher. His famous text-book of three volumes was one of the stable foundations of the science and art of midwifery. Indeed, modern midwifery in this country may be said to have begun with him. For he did two great things. In an age of woman-midwifery, he led the case in favour of the man obstetrician, and he introduced new methods—for the pelvimetry of contracted and normal pelves, for the safe use of the forceps, for the diagnosis and treatment of placenta praevia, and for improved modes of version. He did more than any other individual to advance obstetrics in the eighteenth century.

'No real improvement in the art of midwifery could occur', says Dr. Fairbairn, 'till medical men had the opportunity of studying natural or physiological labour, instead of being called in merely when some extensive or mutilating operation was required. Hence the rise of the man-midwife marks a very important stage in the history of obstetrics.'

This was accomplished, amid much opposition, by Smellie, who, not content to be himself a man-midwife, set about the business of educating hundreds of others. He introduced the plan of extern districts for men students to gain experience in midwifery.

Two remarkable men followed Smellie, William Hunter and Charles White of Manchester. William Hunter was primarily an anatomist. He was a dissector and a follower of the body rather than the book; he added knowledge of the foetal circulation of the placenta, and the anatomy of the gravid uterus; he founded a school of anatomy in which were bred some of the masters of Medicine; and he taught John Hunter. For many years he was the acknowledged leader in midwifery in London. His practice was conservative, and he discouraged the use of the forceps, yet more than any one of his time, by his skill, his anatomical knowledge, and his urbane and conciliatory manner, he commended the employment of the man-midwife, and thus contributed to Preventive Medicine. For wise, careful, and sound midwifery is Preventive Medicine in being. Concurrently with Hunter and indeed a little older than himself, Sir Fielding Ould, who became master of the Rotunda in Dublin, did much to introduce new ideas regarding the actual mechanism of delivery, and in 1742, some years before the actual publication of Hunter's book on the anatomy of the gravid uterus, Ould issued his own treatise on midwifery.

In some ways more revolutionary than Hunter's work was that of his pupil Charles White, F.R.S. He was born in 1728, and after studying in London and Edinburgh became one of the founders of the Manchester Infirmary and medical school. Though he began as a surgeon and did valuable work in regard to the preventive surgery of fractures, dislocations, and haemorrhage, his genius found its fullest expression in his epoch-making treatise *On the Management of Pregnant and Lying-in Women and the means of curing, but more especially of preventing, the principal disorders to which they are liable*, published in 1773.

In this epoch-making little book, White dealt with the general management and hygiene of child-birth, and the cause and prevention

of puerperal fever. He argued that domestic insanitation exerted a direct effect in favour of sepsis, and hence he advocated 'maternity homes'; and as in the early months of pregnancy there were divers physical factors at work which proved mischievous to healthy delivery, he recommended systematic *antenatal supervision*. He claimed that it was retained and putrefying lochia which generated the puerperal sepsis that carried off so many patients. 'The danger does not arise from the smallness of the quantity of the discharge', he says, 'but from its stagnation, whereby it becomes putrid, and in this state is absorbed into the circulation.' After giving a full account of the signs and symptoms of puerperal fever, he offers suggestions for its prevention. These consist mainly of (*a*) cleanliness of the patient, her bedding, clothing, and surroundings; (*b*) the early adoption of the sitting-up position after delivery; (*c*) the dietary; (*d*) fresh air and suitable temperature of the lying-in ward; and (*e*) disinfection. By his method of dealing with the lying-in woman, he claimed that he had never lost a case by puerperal fever. He attributed puerperal sepsis to 'effects of mismanagement in the accoucheur or nurses, or else arises from the patient's own imprudence'.

Here then we have the beginning of the new midwifery, the anatomy of the gravid uterus, antenatal care, the wise use of the forceps—'only 10 out of 1,000 labours required instrumental delivery', was Smellie's standard—and the introduction of what we should call antiseptic practice. From this pioneering work was to come our modern methods of lying-in hospitals and the supervision of maternity and infancy. 'In the nurture and management of infants as well as in the treatment of lying-in women', wrote Lettsom in his *Medical Memoirs* of 1774, 'the reformation hath equalled that in the small-pox; by these two circumstances alone incredible numbers have been rescued from the grave.'

II. *The Prevention of Diseases of Occupation*

I turn now to a different province. As we have seen, medical practitioners in England were much exercised in mind by the effect of the industrial changes which swept over the country in the last half of the eighteenth century. The mill took the place of the field, and Aikin, Percival,

and Ferriar were inquiring into the morbid results of this transference as illustrated in lowered physique, in increased infectious sickness, in higher mortality among women and children industrially employed, in particular forms of disease or in crippling. Twenty or thirty years after their work Mr. Turner Thackrah of Leeds set himself to explore the particular effects of 'the principal arts, trades and professions' on health and longevity as he witnessed them in the rapidly growing industrial city of Leeds.

Mr. Thackrah claimed that though we can neither make man nor improve his original organization, we may injure his character, weaken his frame, and bring upon him premature decay and death by placing him in unfavourable circumstances, including undesirable occupations. He found that the duration of human life was considerably less in the West Riding of Yorkshire and especially in and around Leeds, a manufacturing district, than in other parts of Yorkshire. He divided the inhabitants of Leeds into four great classes—I. Operatives, II. Dealers, III. Master Manufacturers and Merchants, IV. Professional men—and it is on this basis that he discusses the morbid effect of occupation. Then he analyses more fully in this way:

1. Operatives of active habits whose employments are chiefly in the open air (butchers, slaughtermen, drovers, cattle and horse dealers, fishmongers, cart-drivers, brickmakers, coach builders, carpenters, coopers, rope-makers, gardeners, and paviors).
2. Operatives whose employments are carried on in an atmosphere confined and impure (tailors, stay-makers, milliners, dressmakers, spinners, croppers, weavers, shoemakers, curriers, printers, bookbinders, carvers and gilders, clockmakers, smiths, cabinet makers, household servants, waiters, colliers, well-sinkers).
3. Operatives subjected to dust, odour, or gaseous exhalations.
   (*a*) To dust, odour, or exhalations, not decidedly hurtful (starch-makers, bricklayers, lime-workers, tobacco manufacturers, snuff-makers).
   (*b*) To substances or odours apparently beneficial (mustard crushers, brushmakers, glue and size boilers, buckram manufacturers, tallow-chandlers, tanners).
   (*c*) To dust or vapour decidedly injurious (corn-millers, malt-

sters, tea-men, coffee-roasters, rag-sorters, paper makers, worsted and flax workers, cabinet makers, masons, knife-grinders, machine-makers, coppersmiths, tin-plate workers, plumbers, house painters, chemists and druggists).

4. Operatives whose skin is exposed to injurious agents (potters, hatters, grocers, bakers, chimney sweeps).
5. Operatives who are exposed to wet and vapour (scourers of wool, dyers, brewers, paper-makers).
6. Operatives exposed to high temperature or to changes of temperature (bakers, cooks, wool-combers, cloth workers, pressers, cotton and silk spinners, glass workers, ironmongers).

Lastly, he turns to shopkeepers, commercial travellers, merchants and master manufacturers, and professional men such as engineers, priests, doctors, accountants, schoolmasters, lawyers, and other sedentary workers.

By way of summary he concludes that all these types of occupation are liable to be subject to agencies which are definitely injurious (*a*) to the *digestive organs*: excess or deficiency of food; posture of body; great muscular effort; high temperature; atmospheric impurities; mental worry; (*b*) to the respiratory organs: dust; steam; contracted chest; (*c*) to the circulatory system: posture; high temperature; anxiety and worry; (*d*) to the nervous system: atmospheric impurity; poisons; high temperature; posture; anxiety and worry; or to (*e*) vision: close work and atmospheric dust. Mr. Thackrah also refers in detail to the effect of low, varied, or uncertain wage, accidents, deformity, intemperance, and he claims that the way to avoid these morbid conditions and results is the maintenance of high moral character and public tradition, combined with fresh air, bathing, prompt and regular muscular exercise, shorter hours, and a closer personal attention to health.

All this is set out in his small book, which was published in 1831 and opened something of a new chapter in Preventive Medicine in this country, greatly advancing the movement then arising in Parliament in favour of factory legislation. Where had Thackrah got his inspiration?

The answer to this question is interesting. He had obtained it, as he acknowledged, from a medical practitioner

named Bernardino Ramazzini who was born at Carpi in 1633, and practised medicine in the old city of Modena, on the ancient Via Emilia, twenty miles north of Bologna. When Ramazzini was 45 years old Modena established a University and, because of his medical investigations into the diseases of occupations, called him to its Chair of Medicine. This encouraged him in his researches, which he described in his lectures to the students, and subsequently published under the title of *The Diseases of Artificers, which by their particular Callings they are most liable to, with the Method of avoiding them, and their Cure.* This book was published about 1700 and translated into English in 1750. It became the classic on this subject, and inspired Thackrah.

Ramazzini dealt with upwards of fifty occupations, naturally including metal, leather, and silk workers who abounded at and around Modena, and various workers on the land. Being of a universal spirit, and receiving all types of patients, he also studied the effect of every occupation which came before him, including those of midwives and surgeons, athletes and wrestlers, hunters and couriers, those who stand and those who sit at their work. Being also a learned man Ramazzini quotes from the standard medical writings available in his day, including the Greeks. Indeed his favourite author by far is Hippocrates, and next to him Galen, both of whom he prefers to Aristotle and Pliny. He quotes frequently from Etmuller and other early writers on the morbid effects of mining, from Fernelius and the authorities on trade diseases, and from the Englishmen, Boyle, Willis, Morton, and Sydenham.

It is clear that Ramazzini set to work in a systematic way, carefully reading up his subject and himself observing, and he tells us that the two great industrial causes of disease which must be prevented are the noxious qualities of the matter on which the worker is engaged, and the 'violent or disorderly' motions or 'improper postures' of the body of the workman. I will give you three examples of his preventive methods. He finds miners particularly subject to disease, and he says the mines are in need of ventilation, the miner should be clothed protectively, he should use

respirators, he should add fatty broth and milk to his diet, and he should carry metallic antidotes and anti-asthmatic drugs. There are to be health overseers in charge of the miners. Again, the worker in plaster of Paris should be particular in cleanliness, should add milk and fresh butter to his diet, should use antidotes and purgatives, and should not be subjected to the common practice of blood-letting. A third example may be Ramazzini's advice to the nursing mother or wet-nurse in the prevention of infant mortality. This is what he advocates, half a century before the English physicians of the eighteenth century: The child is to be kept scrupulously clean, and the nurse clean and sweet (he supports Galen in the importance of a daily bath and change of linen); the infant is not to be suckled too often, or 'set to the breast' whenever it cries; it is not to have a surfeit at each suckling; the breast is to be given only three or four times in the twenty-four hours; and when weaned the child is to be fed with clean cow's milk to which yolk of egg and a little sugar is to be added. And all this was in 1700.

III. *The Prevention of Scurvy*

The control of scurvy is the grand historical example of the prevention of deficiency disease. It was the first of this large group to be conquered, and its conquest led to reform in more than one direction. Scurvy is a disease which was known to Hippocrates, Strabo, and Pliny, but it was first described by Echthius of Cologne in 1741 and Forestus of Leyden. The English annalists of the eighteenth century were familiar with it and Huxham recommended cider and a vegetable diet as preventive. But it was his contemporary James Lind who must receive the credit of its mastery. He came from Edinburgh, where he was born (in 1716), apprenticed, and trained in Medicine. When 23 years old he joined the naval medical service and served for nine years in the Mediterranean, the Gulf of Guinea, and the West Indies, and it was in his sea-going life that he first met with scurvy as a scourge. Indeed it was after the publication of his first book on *Scurvy* in 1753 that he was appointed Physician in charge of the Royal Naval Hospital

at Haslar, where he had a thousand beds for sick seamen, one-quarter of them suffering from scurvy. It was his experience here which you will find recorded in his second book on the *Preservation of the Health of Seamen*. He held the post for a generation, and died at Gosport in 1794.

Though not widely appreciated in his lifetime, Lind became the leader of the men who conquered scurvy. It was common on land and a pestilence at sea—sporadic, epidemic, and endemic (in certain districts). Lind believed that predisposition to sea scurvy was traceable to continuance of sea-air, cold rainy weather, and wet clothing; its direct causes he attributed to a deficiency in the diet of fresh green vegetables and an excess of salt meat and fish. The scurvy he knew began with listlessness, anaemia, and subcutaneous haemorrhages, and went on to swelling and ulceration of the gums, loosening of teeth, followed by scorbutic ulcers, eruptions, and tumours in different parts of the body, with respiratory complications, scouring, and flux. It was a disabling and mortal condition, which killed crews wholesale. Its prevention was extraordinarily simple, and consisted of putting the seamen into warm, dry, clean, and well-ventilated surroundings, and giving them a dietary consisting of a due mixture of animal and vegetable substance combined with oranges or lemons or their juices.

The story of the control of scurvy is a story of the sea. I have in my hand a list of more than twenty famous voyages from the days of Vasco di Gama in 1497 to Lord Anson's voyage round the world in 1740–4, and Captain Cook's similar voyage in the *Resolution* in 1775, in all of which scurvy provided the tragedy. The struggle against the disease lasted 250 years. Hawkins said that he had in twenty years lost 10,000 men from scurvy, 'the plague of the sea and the spoil of mariners', and it was probably from this disease that both Drake and Hawkins died on the Spanish Main in 1595–6. It was John Woodall, Surgeon to St. Bartholomew's Hospital, and Surgeon-General in the East India Company, who declared the answer. In 1617 he published his *Surgions Mate*, chiefly as a vade-mecum

for young sea-surgeons, and in it he recommends 'two or three spoonfulls of lime juice, and fast after it two hours'. It was Sir John Pringle and Sir Gilbert Blane, an old disciple of Lind, who insisted that the new knowledge as to the prevention of scurvy should be put into practice.

Pringle was one of Boerhaave's men. He had intended to pursue Moral Philosophy and actually became a professor in this subject at Edinburgh, but Lord Stair persuaded him to join him as Physician-General to the army in Flanders. He remained with the army in different capacities for seven years, then settling in London he recorded his military experience as a doctor, and, almost incidentally, produced one of the pioneering masterpieces of Preventive Medicine, a book entitled *Observations on Diseases of the Army*. This book was written in 1752 after Pringle had retired from active service with the army. He corrected it repeatedly and brought out the seventh edition twenty-five years after the first. In this edition he discarded some of the earlier descriptions of fevers, such as nervous, bilious, putrid, or malignant; and he was able to write that, 'how imperfect soever these sheets may be, they have served as a foundation for others to build upon'. This became true, for both the scheme of the book and its recommendations were accepted at the time, and for long afterwards, as something of a model. He began by collecting his notes and observations of disease in the army as he had met with it in the campaigns in the Low Countries and in Germany from 1742 to 1745, in Great Britain in 1745–6, and in Dutch Brabant in 1746–8, under Lord Stair, Marshal Wade, the Duke of Cumberland, and other commanders. Pringle became interested in the 'septic principle' because of Boerhaave's work, the numerous cases coming under his own care, and the view of Lord Bacon that the exploration of its causation would lead to new light on 'some of the more abstruse operations of nature'. As a result of his studies and experience he subdivides the causes of diseases most incident to an army into five: (1) those occasioned by exposure to heat and cold; (2) those occasioned by moisture; (3) those arising from putrid air; (4) those due to errors in diet; and

(5) those originating from excess of rest or motion, of sleeping or watching, and from want of cleanliness.

Many of his cases he relates to the effect of season, intermittency of fevers, fermentation, or putrefaction. Not the least farseeing of Pringle's work is to be found in a recorded series of experiments as to the effect of antiseptics upon fermentation and putrefaction, submitted to the Royal Society in 1750–2. He quotes Lord Bacon's remark that, 'it is excellent use to inquire into the means of preventing or staying putrefaction, which makes a great part of physic and surgery', and describes his own experiments on the chemical substances which proved 'antiseptic', to use his own term, when applied to putrefying blood, urine or meat, and to various kinds of fermentation. Those important experiments form a comparative series to some of the investigations carried out a century later by Lister.

Pringle's preventive methods began a new practice in the army and later in civil life. 'Heat or cold exposure' was to be avoided by suitable clothing, bedding, and barracks; 'moisture and dampness' by land drainage, ventilation, cleanliness, and dryness; 'putrid air' by regular renewal of camp, effective sanitation, open-air life, ventilation of hospitals, absence of overcrowding; 'bad dietary' by improving quality of food and adding fruit, fresh vegetables, and vinegar; and 'fatigue' by rest and exercise and good boots. It now sounds very elementary, but then it was new. Captain Cook, Sir Gilbert Blane, and Florence Nightingale were to be its masterly exponents.

'The means of prevention are more within our power than those of cure; for it is more in human art to remove contagion, to alter man's food and clothing, to command what exercise he is to use, and what air he is to breathe, than it is to produce any given change in the internal operations of the body.'

These are the wise words of Sir Gilbert Blane, physician to the navy under Lord Rodney. Like Pringle he retired early from the service, and like him recorded his experience. In 1785, when only 38 years old, he wrote *Observations on the Diseases of Seamen*, wherein he explains the prevention of 'fevers, fluxes, scurvy and ulcers' which were the curse of the navy. But happily he could do more than explain. He

could enforce. This he did in two ways: he issued popular leaflets and he persuaded the Admiralty to put an end to scurvy by regulation in 1796 that lemon juice should be prescribed for all naval ratings. He more than any man secured for the navy clean dry ships, wine instead of rum, ample dietary, medical supervision, adequate hospital accommodation, and oranges or lemons or their equivalent in lime juice.

IV. *The Prevention of Lead Colic*

This is a short story. As long ago as 1603 Musgrave had met with colic following cider-drinking, and one hundred and fifty years later Huxham described some similar cases in Devonshire which appeared to occur most frequently among cider drinkers in the autumn. In 1757, five years later than Huxham's account, another of Boerhaave's men, Theodore Tronchin of Geneva, the favourite physician of Voltaire, described some cases of colic following the drinking of wine which had been sweetened with lead, just as Thomas Cadwalader of Philadelphia had found a few years before that colic and lead palsy occurred in some of his patients who had habitually used Jamaica rum which had been distilled through lead piping.

Now the solution was to be discovered by Sir George Baker, the scholarly son of a vicar in Devonshire, who, having retired to London from a country medical practice in Lincolnshire, was consulted one day about some cases of colic and arm paralysis at Alphington in Devonshire, not far from his own birthplace. He went down to explore, and this is what he found. Like Huxham ten years before, he learned that colic was especially prevalent in Devon, periodically in the autumn, and that it appeared to affect those making cider; that between September 1762 and July 1767 as many as 285 patients had been admitted to hospital in Exeter with colic and paralysis of the arms, somewhat similar admissions being made at the Bath hospital; that the symptoms suggested the lead poisoning of painters; that eight times as many patients with this malady came from Devonshire as from cider-making localities in the

neighbouring counties of Hereford, Gloucester, and Worcester; that the apples from which the cider was produced in Devonshire were crushed in stone malaxers or cider-presses clamped together with iron fixed by melted lead, or in presses lined with lead, and in certain cases the apples had been stored in casks or vats containing leaden weights to prevent the cider turning sour; that cider thus stored or produced would be likely to absorb lead; that chemical analysis proved that the Devonshire cider contained lead in solution, whereas the Herefordshire did not; and that other channels of lead poisoning were on investigation found to be free from lead.

Here we have in outline the application of the scientific method in the investigation and prevention of a form of lead colic and paralysis derived from drinking a beverage contaminated with lead. It is a little masterpiece of inductive logic. It terminated endemic lead colic from drinking cider, wine, or spirits, and though it did not end plumbism from lead-contaminated drinking-water (as occurred for instance in Sheffield in 1889) it demonstrated the mode of investigation of all such poisonings, and it proved the method of their prevention.

V. *The Prevention of Small-pox*

The greatest of all the medical achievements of the eighteenth century was the introduction of the practice of immunity. London in the eighteenth century was besieged by small-pox, and it was felt that something had to be done. Now in 1713 Dr. Timoni, a Greek of Constantinople, wrote a letter to Dr. Woodward of London giving him 'an account of the procuring of small-pox by incision or inoculation, as it has for some time been practised at Constantinople'. This letter excited much interest in English medical circles, and Dr. Pylarini of Venice, who had in fact practised inoculation in Constantinople, was induced to give his version of the practice. Thus it came about that in 1721 inoculation by slight puncture and insertion of the fluid matter from a small-pox sore was tried tentatively in London. In the meantime, Lady Mary Wortley Montagu, the

wife of the British Ambassador to the Porte, 1717–18, had had her own child, a boy aged 5, inoculated by a Greek woman under the direction of Maitland, surgeon to the Embassy, and in 1721 Lady Mary got Maitland similarly to inoculate her little daughter, 4 or 5 years old, in London. As these and other cases, including six Newgate convicts, quickly recovered, the Princess of Wales had her two children inoculated, and thus a fashion for the practice was established. Owing to the advocacy of Mr. Maitland and of Dr. Nettleton of Halifax, there were as many as 200 inoculations in 1722, and some 300 in 1723. No doubt the custom would have spread had it not been for some public opposition and certain apparently inexplicable fatalities, the effect of which was that from 1728 to 1740 inoculation fell into abeyance.

Then it happened that at about the same time that inoculation was introduced here, it was also tried at Boston in New England, and later on in 1738 at Charleston in South Carolina, and there the practice followed by Kilpatrick was to inoculate very slightly and from artificially produced small-pox—i.e. from the inoculated and not from natural small-pox. In 1743 Kilpatrick came to London and, assisted by Dr. Frewen of Rye, a pupil of Boerhaave, carried out a large number of inoculations from arm to arm—artificial small-pox derived from artificial small-pox, and in 1754 the College of Physicians declared in favour of the method. Sutton went a step farther in attenuation by inoculating with recent fluid matter before the variolous fever had matured. At the same time he was careful to prepare his patient by spare dietary, fresh air, and refrigerating drinks. Baron Dimsdale adopted these measures when he inoculated the Empress of Russia in 1768. The practice soon spread, and was encouraged by charitable agencies and dispensaries for gratuitous inoculation of the poor; and Lettsom projected a scheme for inoculating infants in their homes. Yet in spite of the widening custom of inoculation, it did not prove itself a preventive of the disease. Indeed, by cross-infection it increased its incidence, if not its fatality. Then, as now, there were also mild types of

natural small-pox. 'There were cases which a physician could not save', said Wagstaffe, 'and cases which a nurse could not lose.' But the London Bills of Mortality continued to show to the end of the century an average of 1,800 to 2,000 deaths from small-pox every year.

Edward Jenner was born in 1749 at the vicarage of Berkeley, in Gloucestershire. After schooldays he was apprenticed to Mr. Ludlow, a surgeon at Sodbury, near Bristol, and there, about 1768 or 1769, he heard a young countrywoman say that she could not take small-pox, 'for I have had cow-pox'. This he pondered in his mind. In 1770, when he was 21, he came to London to be a resident pupil of John Hunter. Both of them were naturalists, and from the elder the younger received a new and enlarging inspiration, an awakening which is apparent in the interesting correspondence which passed between them. Happily Jenner declined an offer to go seafaring with Captain Cook, and after his two years with Hunter he returned to Berkeley, and there lived the busy life of a country practitioner.

In 1774, Jesty, a Dorset farmer, performed inoculation on his wife and children, using cow-pox material in place of small-pox, and in 1780 Jenner spoke to one of his fellow practitioners on the idea growing in his mind that cow-pox might prove the antidote to small-pox. Early in 1788 he married, and in 1789 he made the great venture and inoculated his own child, a few months old, with swine-pox matter, and subsequently on three occasions with small-pox virus. *None of these small-pox infections gave the child the disease.* Seven years later (1796) he inoculated James Phipps, aged 8½ years, with cow-pox matter from the hand of a dairywoman who had contracted cow-pox from her master's cows, and three months later he inoculated the child with matter from a small-pox case. *Phipps did not get the disease.* Jenner continued his observations, and two years later published his famous *Inquiry into the causes and effects of the variolae vaccinae, a disease discovered in some of the western counties of England, particularly Gloucestershire, and known as the Cow Pox* (1798). His 'vaccination' became more and more a universal method for preventing

small-pox, and was recommended by the College of Physicians in 1807. Then, as now, there were critics and opponents.

Let us consider what it was that Jenner actually did. He did not discover vaccination, but he described cow-pox as he saw it in Nature, and he contributed to its differentiation from other similar outbreaks among animals. He showed that cow-pox was inoculable upon man, and could be transferred from man to man. Above all, he *proved* that vaccinia in man protected against small-pox. It may be said that not one of these three discoveries was new, and, speaking generally, that is true. Different persons, medical, veterinary, or lay, had made observations on these points. What Jenner did was to bring them together and *prove their validity*. He also made communal vaccination practicable. Since his day the whole method of procedure in vaccination has been revised, and, in place of crude vaccinia, glycerinated calf lymph has been adopted.

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VIII

PATHOLOGY AND BACTERIOLOGY

'*Pathology is an aspect of physiology*.'—CLIFFORD ALLBUTT.

Synopsis of Lecture VIII

The necessity of pathology to Preventive Medicine.

Forerunners of Morgagni (Glisson, Bonet, Valsalva). The autopsy, Paré, 1562. Morgagni's work on morbid anatomy, *De Sedibus et Causis Morborum*, Padua, 1761, post-mortem signs in organs and correlation with clinical records. (*a*) Baillie's system of pathology, 1795; (*b*) Tissue pathology, Bichat, 1799; (*c*) Experimental pathology, Hunter (1728–93); (*d*) Cellular pathology, Virchow, 1858; (*e*) Neurological pathology, Charcot, 1876; (*f*) Chemical pathology (Ehrlich and Fischer); (*g*) Comparative pathology.

The growth of morphological and histological pathology, organs, tissues, cells; the causes and variety of changes in structure, their correlation with clinical signs; disturbance in function; the means of prevention.

The Advance in Bacteriology. The early observers, Fracastor, Leeuwenhoek, Bassi (silkworms), Cohn (botanical classification).

The evolution of modern bacteriology and parasitology presents several aspects:

(1) The development of technique—microscope, staining reagents (aniline dyes, 1856), freezing, and embedding, microtome, fluid and solid media for cultivation, sterilization, inoculation of animals, filtration, anaerobic culture, chemical tests.

(2) Koch (1843–1910) started the great epoch of discovery of specific pathogenic bacteria (1876) which between 1881 and 1898 revealed the cause of tuberculosis, glanders, pneumonia, cholera, diphtheria, tetanus, Malta fever, plague, botulism, and dysentery.

(3) Pasteur (1822–95) explored the production of the virus of infective disease and the natural and artificial means of recovery. His contribution covered the following: molecular dissymmetry (1848), fermentation (1857), spontaneous generation (1862), diseases of wine (1863), of silkworms (1865) and of beer (1871); the cause of virulent diseases (anthrax, chicken cholera, and swine erysipelas) (1877), preventive vaccinations (1880), and rabies (1885).

(4) Immunity—(Jenner 1798) humoral theory, alexins, phagocytes (Metchnikoff), antitoxins (Behring, Kitasato, Ehrlich), haemolysis (Bordet, Ehrlich), agglutination, antigens and anti-bodies, sero-diagnosis.

(5) The cause of protozoal infections—malaria (Laveran, Manson, Ross), amoebic dysentery, trypanosomiasis, Leishmaniasis.
The control of the tropics.

VIII

PATHOLOGY AND BACTERIOLOGY

We have seen that the interpreter of Preventive Medicine must be a clinician as well as a physiologist. He must also be a pathologist. So great has been the advance in modern times of the applications and forms of sanitation and an improved external environment, and more recently so wide has become the sphere of direct prevention, that we are liable to forget that at the back of this progress there stand the new sciences of physiology and pathology. They are not separable, for 'pathology is an aspect of physiology'.

Can we conserve health or attempt wisely to prevent disease or its sequelae without a good working knowledge of the *seats* of disease in the body, the *processes* of disease, and the *causes* of disease? A moment's reflection will convince us that we cannot. Yet all too often we are satisfied with a general knowledge of causation, to know that the infections are primarily caused by pathogenic germs—leprosy, enteric, tuberculosis, diphtheria, cholera, tetanus, plague, syphilis. We must not, however, overlook the fact that leprosy was controlled long before Hansen's discovery of its bacillus in 1871, that tuberculosis was declining before 1882, when Koch proved its causation, and that small-pox has been prevented though its cause has not yet been found. The fact is we require a wider knowledge of pathology than mere bacterial causation.

Consider the large practical issues raised by the following illustrations. Preventive midwifery depends upon a knowledge of the normal and abnormal pelvis, of the physiology and diseases of pregnancy, of the pathology of the gravid and non-gravid uterus, of the morbid conditions liable to be set up in the cervix, of the effect of sepsis and toxaemia at childbirth; farther back there is the great question of nutrition, or malnutrition and deficiency, in its effect upon the child, the girl, the adolescent woman, the pregnant woman, the mother; and there is, finally, the widespread gynaecological aftermath. There is also the infant, and the

risks of its neo-natal or post-natal susceptibility or mortality. We can never become masters of midwifery, never reduce maternal mortality, merely by the improved management of delivery. We must become close observers of the whole of pregnancy, the normal or abnormal progress of the long course of gestation from the beginning.

Again, when we come to adolescent and adult life premature mortality is mainly attributable to pathological conditions of the respiratory, circulatory, and alimentary systems, for it is slowly produced disease in these three tracts which furnishes the largest contribution to the total national death-rate. What is the reason for the high incidence of pneumonia, of endocarditis, or of gastric ulcer?

As age advances we must learn the processes which lead to the paralyses, the arteriosclerosis, and the oncoming breakdown and end-results of the misfunctioning of organs during adult life.

We are coming to see that premature death is not the 'thief in the night', not due to the sudden illness, which it has been assumed to be. Here is a dilated heart and a high blood-pressure in a man of 60, traceable to excessive strain in the athletics of youth and its predisposing ill effects; here, an endocarditis, which originated in an untreated rheumatic fever of childhood; here, a gastric ulcer born long ago in errors of diet and metabolism; and here a cancer of the cervix following chronic irritation of many years before.

The medical officer of health will know from a careful study of the weekly death and sickness certificates of his area, at ages under 50 years, with what he has to contend and learn how to prevent. Deficiency diseases will stare him in the face, rickets, scurvy, tuberculosis, malnutrition, anaemia, dental decay; close behind them will come intoxications, alcoholism, acidosis, food poisoning, gout, obesity, and the aberrant forms of endocrine disorder; always there will be cancer (skin, breast, stomach, uterus) for his consideration; there will be the pneumoconioses arising from urban life or industrial occupation, and their forerunners in bronchitis, pleurisy, and pneumonia; mental disease of differing degree and kind abounds, from the mentally

dull and feeble to the moron, from the nervous disease which is mental in origin to the mental aberration which is nervous in origin, from transient mental disease to the grave infections of encephalitis, poliomyelitis, and cerebrospinal fever; though they do not always appear in the death certificates there will be the wide-sweeping and almost universal background of haemorrhoids, varicose veins, 'glands', dyspepsia, lumbago, 'rheumatism', measles, and constipation; and always there will be the protean and ubiquitous influenza and the infectious and parasitical diseases. What can we possibly understand of the conditions illustrated in this list *without studying their pathology*? Nor is it only a matter of understanding, it is also a matter of action, of treatment and prevention, and of the kind of hospital or sanatorium that is necessary. There is the ever-widening field of preventive orthopaedics, of straightening the crooked, of transplantation and transformation of parts, of restoration and re-education of function. What can be done, if the morbid process in question is not itself appreciated and comprehended?

The Study of the Morbid Process

The autopsy is an ancient practice. For the purpose of embalming it is thousands of years old, for curiosity and inquiry it is hundreds of years old, for medical investigation it comes to us from the Alexandrian School and Benivieni in Florence in 1507, and for judicial purposes it dates back at least to Ambroise Paré in the sixteenth century. Yet the pathological study of the Renaissance was indiscriminate and diffuse, and the morbid anatomy arising from the pioneering work of Vesalius was piecemeal and unsystematic.

It was Morgagni (1682–1771), the friend of Ramazzini, and the pupil of Valsalva, who began the scientific study of pathology as Professor of Anatomy at Padua. He was 79 years old when he published his great book on the *Seats and Causes of Disease*, and witnessed the issue of several new editions before he died in his ninetieth year. This book consisted of five volumes of seventy letters to a young

and unnamed friend. It was prolix, descriptive morbid anatomy, the post-mortem findings correlated with the clinical signs and symptoms. It contained the first detailed descriptions of syphilitic aneurism and of lesions of the vascular system, recorded the causes in life of the morbid conditions found after death, and, probably at the instigation of Ramazzini, discoursed on the morbid anatomy of diseases of occupation. The book contains particulars of some 700 autopsies, personally identified, 'a certain honest citizen', 'a good pious virgin', 'a most powerful monarch', or 'a Paduan nun'—merchants, lawyers, thieves, robbers, priests, bishops, princes are memorialized in its pages.

The *De Sedibus* of Morgagni laid the foundations of modern pathology and became one of the great books of medical literature. It taught men to think anatomically of disease, to envisage the relation of organs in life and death, to describe disease, as Sydenham desired, as a form of natural history. Matthew Baillie, who was born in the year of the publication of Morgagni's book, followed in his footsteps and produced an English book on pathology from the clinical standpoint. Although it appeared two years after the death of John Hunter, it had some of his inspiration in it. It was, however, Baillie's French contemporary, Bichat, whose genius introduced the idea of *tissue* pathology as distinct from Morgagni's pathology of *organs*. Unhappily this great thinker died at the early age of 31, but he left his mark on the records of the character of diseased tissue, and taught men to concentrate on the misfunctioning of tissue as giving that character, a great step in advance. 'Dissect in anatomy,' he told his students, 'experiment in physiology, follow disease to the necropsy.' But it was John Hunter who introduced the idea of experimental pathology when Bichat was a child.

The world had to wait nearly sixty years for Rudolf Virchow, of the Charité in Berlin, to build pathology on the microscopic work of Muller and Schwann, and lead it the third step, namely, from the pathology of tissues to that of *cells*. He said the healthy body was 'a cell-state in which every cell was a citizen', and that disease was 'a conflict of

citizens in this state, brought about by the action of external forces'. And so he built his conception of pathology. Here I may remind you that Virchow was not only pathologist but also politician, not only a laboratory investigator but a leader in practical Preventive Medicine. He explored the incidence of typhus in Silesia, advocated public health measures in the Reichstag, and helped to secure a sewerage system for Berlin, the German preventive campaign against tuberculosis, the introduction of anthropometry, and the medical inspection of the six million school children in Germany. He died in 1902.

There was a fourth great school of pathology. Morgagni of Padua began the scientific study of the morbid anatomy of organs; Bichat of Paris that of the pathology of tissues and their consequent change in function; and Virchow of Berlin introduced cellular pathology. Fourthly came Paul Ehrlich of Breslau, who by using Weigert's differential staining became the founder of chemical pathology. His selective staining of cells and their invaders led him to invent modified dyes, germicidal chemical bodies, with which he attacked the spirochaete of syphilis; how he tried one fortified dye after another until over 600 lay discarded on the scrap-heap, but the six hundred and sixth (606) proved potent, is one of the inspiring stories of modern research.

All this looks at first sight to be remote from Preventive Medicine. But it is not so. Morgagni, Bichat, Virchow, and Ehrlich were in the truest sense preventive pioneers. Their work laid the foundations of scientific prevention. It was not only that they demonstrated the factors of all morbid processes and thus showed both the direction and the occasion of methods of prevention of the sequelae of disease, but they and their disciples were themselves the leaders in practical application. Morgagni established the conditions by which his patients had reached the end-results; Bichat, alas, died too young to garner his fruits; Virchow became a practical preventive statesman; and Ehrlich furnished the germicide which destroyed the infectivity of the spirochaete of syphilis *in situ*. These forward

steps came from Padua, Paris, Berlin, and Breslau. From the last-named centre came also Weigert, whose staining methods made much of the new diagnosis possible and whose studies on degeneration of tissues and miliary tuberculosis carried him to the problems of repair, of which John Hunter had dreamed, and which Ehrlich solved. A contemporary worker and disciple of Virchow is seen in Edwin Klebs, who successively filled the Chair of Pathology in Berne, Wurzburg, Prague, Zurich, and Chicago, and forged the link between the new pathology and the newer bacteriology. He investigated the cause of sepsis, was one of the first to sterilize fluids by filtration, discovered with Löffler the diphtheria bacillus, and showed that aetiology was the precursor of prevention.

As we pass from one pioneer to another, from the doctrinal schools to Glisson and Willis, and from them to Morgagni and Bichat, Bernard and Virchow, and thus to modern pathology, we are the witnesses of a continually developing conception of disease. What *is* disease? they all ask themselves. They all see it is the abnormal in organs, tissues, or cells. But how does it pass from normal to abnormal? In the eighteenth century Glisson and Haller suggested that the *fons et origo* was 'irritability'. Modern pathology has confirmed that conception, and, whatever was the nomenclature, demonstrated that disease is due to a great variety of irritations—arising from malfunctioning or organic and inorganic poisoning. Exact definition may well be impossible, or is at least precarious and provisional. Yet we now know that disease is a process rather than an objective entity. It is not separable from life and function, whether we prefer a humoral, a vitalistic, or a mechanistic explanation. It is a dis-ease, or disturbance or succession of disturbances induced by internal or external agency, and usually producing tissue change. It is a dissociation, a disharmony, a departure from normal physiological functioning of the whole body or a part, a reaction response to harmful factors of the internal or external environment.

The prevention or postponement of disease can therefore only be achieved by following Nature, namely (*a*) by

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removing or mitigating injurious influences on the body, (*b*) by restoring the balance and equilibrium of its internal environment, and (*c*) by surrounding it with a favourable external environment.

The Advance of Bacteriology

In no department of pathology has modern progress been greater than in bacteriology. The early workers have, almost suddenly, seemed to become ancient and of historic interest. They had the theory and they had the imagination. Contagion was believed in by the Jews as far back as the Pentateuch, but, rather strangely, there is no reference to it in the Hippocratic writings, though there is in the historians, Thucydides and Diodorus Siculus. In the early Renaissance Boccaccio and other writers refer to the spread of disease from person to person, and indeed few who lived through the Black Death could doubt that the plague might thus be contracted.

The first man who attempted an intelligent explanation of such contagion was Girolamo Fracastoro of Verona (1483–1553), whose *De Contagione* was published in 1546. He likened it to the corruption which passes from grapes or apples in contact with each other, and he supposed that contagion was spread by seeds, or *seminaria*, which were transmissible by direct contact, by fomites such as clothing, and at a distance by air. The next outstanding believer in such seeds was Anthony van Leeuwenhoek of Delft, and he believed because he saw, for he it was who first discovered living microbes. After his day's work as linen-draper this remarkable and untutored man spent his leisure, at the back of his little shop, polishing lenses and using them as magnifying glasses of 40 to 300 diameters. With these lenses he examined contaminated rain and well water, yeast cells, the sordes of the teeth, &c., and wrote a series of letters, 200 in number, to the Royal Society, to which he was elected a Fellow in 1680. In one of these letters dated October 9th, 1676, he described different forms of living bacteria, and, in letters of 1683 and later, bacteria which he obtained from his own teeth. He left behind figures of

the different forms seen by him. He has rightly been called the first bacteriologist and the first protozoologist.

Yet it was a long time before the relationship of these 'living animalcula' came to be associated with disease. The proof of it was established by Agostino Bassi in 1835, who thus became the founder of the doctrine of pathogenic micro-organisms of vegetable origin. Like Leeuwenhoek, Bassi was an untrained man, pursued by poverty, ill health, and partial blindness. What he did was this. He took some silk-worms affected with muscardine (a parasitic fungoid disease), passed them through a flame, and inoculated healthy silk-worms with particles from their bodies, thus setting up the disease. I must mention one other pioneering step, namely, the first classification of bacteria by Ferdinand Cohn of Breslau in 1874. As a botanist he raised the whole question of the arrangement of bacteria in genera and species, not on form only but upon their total character, and their similarity to and difference from other types of lowly life. From him therefore derives our classification into micrococcus, bacillus, vibrio, spirillum, or spirochaete.

This brings us to the modern period of bacteriology, the period of the giants. Spallanzani, Pasteur, and others had been working at spontaneous generation for some years when a country doctor at Wollstein, a small town in Posen, working with primitive equipment, announced one of the first of the great medical discoveries. This was Robert Koch, who on April 22nd, 1876, wrote to Cohn to tell him that he had worked out the complete life-history of the anthrax bacillus, which had been seen by Pollender in the blood of cows in 1849 and described by Davaine in 1868. Cohn invited Koch to Breslau, who in three days convinced his friendly critics of the importance of his discovery.. This was an historic demonstration. This is what Professor Bulloch says about it:

'Koch (1876) had occasion to study anthrax in domestic animals, and had come to the conclusion that many of the facts suggested that the bacillus was capable of spore formation. Placing minute fragments of fresh anthrax spleens in drops of sterile aqueous humour or blood-serum he set himself to watch, hour after hour, what took

place. He saw the bacilli grow into long filaments, especially at the edge of the cover-slip, and, as he watched, he saw rounded and oval granular bodies appear inside the filaments. The bodies became clearer and stood out as prominent objects. He realized that they were spores, which had not been seen before. In slides there was every stage from the bacteridium of Davaine to the fully formed spore. On a primitive warm stage at different temperatures he determined accurately the optimal thermal conditions for spore formation. By ingenious methods he disposed of the possible criticism that the spores belonged to some other micro-organism which had wandered on to the slide from without, and he succeeded in showing that under suitable conditions the spores grew again into anthrax rods. Koch described and figured the germination of anthrax spores, and showed that they were highly resistant to injurious influences. He grasped, at once, the significance of this fact from the epidemiological point of view. Using primitive methods he showed that anthrax was transmissible from mouse to mouse in a series of twenty generations, and that the lesions in each member of the series were identical. He also worked out the dissemination of the bacilli in different animals.

'Koch showed that anthrax and experimental septicaemia differ from each other, although in putrid infusions of vitreous humour he found bacilli almost identical in form and spore formation with anthrax bacilli. Inoculation of such bacilli did not result in anthrax. From facts like these Koch concluded that "only one kind of bacillus is in position to induce the specific morbid process, whereas other schizophytes are not, or, if pathogenic, they act in a manner different from anthrax". Koch thus clearly enunciated the idea of a specific virus. In the case of anthrax in frogs he gave an accurate description and figured the changes subsequently known as phagocytosis.

'Koch's discoveries on anthrax, published under the aegis of Cohn, were at once recognized as from the hand of a master. Through the exertions of Cohn and Cohnheim he was able to free himself from the claims of practice, and enter upon that long career in which he was acknowledged as one of the greatest exponents of bacteriology. Koch's anthrax research was born complete, and no substantial changes have since been made in it.'

From now onwards the advance of bacteriology proceeded apace along two separate lines, both of which made famous the last quarter of the nineteenth century. Koch investigated technical methods for the examination, separation, and cultivation of different disease-producing organisms,

whilst Pasteur continued his experimental study and analysis of fermentation, the diseases of wine, of silk-worms, and of beer—in which he had been engaged for nearly twenty years before Koch had elucidated anthrax.

Robert Koch

It will be convenient first to follow Koch, the junior pioneer. He had been born in Hanover in 1843, and educated at the gymnasium of his native town. Then he went to the University of Göttingen, from which he graduated in Medicine in 1866, and there he had been influenced by Henle, whose theories of infection may well have started him on his life work. But he had to earn a living and this he did as district physician at Wollstein, where he varied his long country journeys by evening study with the microscope. His anthrax work made him known, and two years later, with the financial help of friends, he set to work to study traumatic infectious disease and entered the Imperial Health Department with Löffler and Gaffky as his colleagues. Here he established what came to be known as Koch's doctrine or 'postulates' for the isolation of pathogenic germs—to find the germ in the diseased animal, to separate the germ and cultivate it outside the animal body, to prove its inoculability into susceptible animals, and to isolate it from the inoculated animal and re-cultivate it. Here, too, in 1882 he discovered the bacillus of tuberculosis; and here he isolated the cholera bacillus, and proved its transmission by water. As a result of this work he was appointed Professor of Bacteriology in the University of Berlin, and one of his first achievements was the introduction of tuberculin. He was promptly promoted to be head of the Institute of Infectious Diseases, and from that authoritative position he began a world-wide career. He went to the Cape to investigate rinderpest in 1896, to India to investigate the plague in 1897, and to Hamburg and to Egypt to inquire into cholera. He wrote on the prevention of water-borne disease by filtration and sterilization; he started a national campaign against tuberculosis; he explored the trypanosomiasis of the tropics; and he worked

at the prevention of typhoid, the bacillus of which his friend Gaffky had described in 1884. He died, worn out but full of honour, at Baden in 1910.

No doubt Koch made mistakes and some of his speculations were subsequently disproved. But he achieved a mighty work for Preventive Medicine which leaped forward into public comprehension and application. Before 1882 we knew the causal micro-organisms of leprosy and anthrax. But by the accurate use of Koch's methods by himself and by his successors, a dozen new pathogenic germs were discovered between 1882 and 1900, including the causal bacilli of tuberculosis, cholera, diphtheria, typhoid, tetanus, and plague, six of the great world-wide diseases which had hitherto lain beyond our reach.

How did he do this? or rather what was it that he and his colleagues did which thus opened the door to these brilliant examples of the new learning? I believe the answer is that the main contribution of Koch's school was the introduction of a novel and superb technique. Briefly it consisted in the staining, cultivation, and sterilization of micro-organisms. We have already seen what Carl Weigert did in his laboratory at Breslau. In order to study the structure of tissues and cells, and still more of micro-organisms, it was necessary to stain them. At first carmine was used, followed by haematoxylin, then came the preparation of dyes from aniline and coal-tar, and fuchsine and methyl-blue arrived; to them was added logwood, Bismarck brown, and methylene-blue—the very words are reminiscent of early days in the laboratory. Now this was the sphere in which Weigert, Koch, and Ehrlich, the master-stainers, won their repute. The technique developed rapidly, almost from day to day, and Löffler's blue, the Ziehl-Neelsen process, and Gram's stain emerged. Koch used methyl-violet for his anthrax preparations, methylene-blue for his tubercle bacillus, and logwood for cilia. The master-stainers worked out ingenious ways of revealing the bacillus, its internal protoplasm, its capsule, its cilia.

Even more contributory to the separate isolation of one organism from another was the invention of culture media

which would solidify. To cultivate bacteria it was necessary to grow them in favourable nutrient fluids or media—'Pasteur's fluid' of water, candy sugar, and ammonium tartrate, Cohn's fluid, peptone, broth—but though organisms grew and flourished they could not by such media be separated the one from the other. So potato, starch, egg-albumin, and bread were used, but not with entire success. The solution of the problem was suggested by Brefeld to be in gelatin, and Koch developed the idea. The fluid containing the organisms was diluted again and again, and the final dilution became, on cooling, a sterile, transparent, and solid medium, the nutrient fluid being solidified by 2 to 5 per cent. of gelatin, which thus became 'nutrient gelatin'. On the solid gelatin in the test-tube appeared the separated 'colonies' grown from the single bacillus, or the fluid gelatin was poured upon a Koch's plate of glass or into a Petri dish and there solidified. This method of pure cultivation which Koch completed in 1881 yielded within a few years an amazing harvest of discovery, which fell largely though not exclusively to the German bacteriologists.

Here is an interesting historic episode recorded by Bulloch:

'In this simple way Koch had solved a problem which three years previously he had deemed to be almost incapable of solution. He soon gained world-wide fame by the demonstration of his method and results in the Physiological Laboratory in King's College, London, at the International Medical Congress in 1881. The audience at his demonstration included Pasteur, Lister, Sanderson, and Chauveau. Lord Lister once told me that the moment Pasteur saw Koch's cultures he turned to Koch, whom he had not met previously, and said, "C'est un grand progrès, Monsieur!"—a statement which history soon verified. It was in the same Congress that the English heterogenist, Charlton Bastian, reiterated all his old views on spontaneous generation with his accustomed fervour. Addressing him, Pasteur dramatically raised his hands to heaven and exclaimed, "Mon Dieu, mon Dieu! est-ce que nous sommes encore là? Mais, mon Dieu! Ce n'est pas possible!" '

One further word must be said of Koch's contribution to the whole process of sterilization. It would be almost

true to say that he did for laboratory technique what Lord Lister did for hospital surgery. He enforced sterilization of apparatus and technique in the separate cultivation of micro-organisms, introducing methods or modifying the methods of others to secure sterile results. Otherwise his plans would have miscarried. Not only did he invent various forms of Koch sterilizers and autoclaves, but he advocated modes of sterilization and filtration of water-supplies, which proved an invaluable beginning to larger and wider applications.

Thus the school which Koch created moved the medical profession forward in its knowledge of the causes of infective disease, in the diagnosis and differential diagnosis of such disease, in the application of sterilization to such disease, in affording new means of determining the channels of such infection—personal, 'carriers', water, and food—and in a method of testing the occurrence, the recurrence, and the arrest of infective processes.

Louis Pasteur

These seem to be far-reaching results. What did Louis Pasteur add to them? He, older than Koch by twenty years, was born at Dôle in the Jura in 1822, the son of a Napoleonic soldier, turned into village tanner, but he was an artistic, observant, diligent, religious tanner, a dutiful father with a clever and competent wife. When the boy was 16 he was sent to the École Normale in Paris. But in a few weeks he returned, home-sick, to become a local pupil-teacher for four years. Then came three years of happy work at the École Normale followed by increasing interest in chemistry and crystallography. When he was 23 he was appointed a teacher of Physics, first at Dijon and afterwards at Strasbourg, where he married the daughter of the Rector of the University. Subsequently he travelled, with the object of studying different types of tartaric acid, and the crystallization and fermentation associated with it, and in 1854 he became Professor of Chemistry at Lille. Here his days of preliminary preparation ended and his own great researches began.

'In the fields of observation', wrote Pasteur, 'chance only favours the mind which is prepared.' A local brewer, named Bigo, consulted the young Professor about the souring of his beer, and this was the commencement of Pasteur's prolonged studies into the causation of fermentation, especially lactic and alcoholic. His inquiries carried him into the controversy as to spontaneous generation as well as the 'diseases' of beer and wine, and he was able to prove that all fermentation is produced by the growth of germs, that each fermentation has a particular germ, and that no germ is spontaneously generated. 'What would be most desirable', he wrote, 'would be to push these studies far enough to prepare the road for a serious research into the origin of various diseases.'

Pasteur had not long to wait for this further step. In the spring of 1865 his old master and encourager, J. B. Dumas, wrote and asked him to investigate the cause and remedy of a ruinous epidemic of silk-worm disease in the southern Departments of France. After six years' work he showed that the disease was both contagious and hereditary; that it was spread by contact with diseased silk-worms or with their eggs, contaminated with the infection; and its solution was to procure healthy eggs, and preserve the grubs from contamination during development. It was this task which turned his mind more directly to the investigation of disease in man. He confirmed Koch's work on anthrax and its resistant spores, but he also found the spores in soil contaminated by the carcase, excreta, or blood of an anthrax-infected animal, even as long as ten months afterwards, and that this soil infection was a channel of dissemination to other cattle. Thus was it found necessary to destroy the bodies of infected animals to prevent the spread of the disease. Pasteur showed that the spores were brought to the surface of the soil by earthworms, in the castings of which anthrax spores were found. Concurrently with his study of anthrax Pasteur was working at chicken cholera, and in regard to it he showed that old or repeatedly transplanted cultures became enfeebled in virulence, that virulence could be increased or decreased in degree, and that when the

virulence was decreased to a certain degree ('attenuated' as he said) it could be used as a *vaccine*, like Jenner's variola-vaccine. So he inoculated healthy fowls with attenuated viruses, and then in a few days applied virulent viruses, with the result that the fowls did not die of cholera. Turning this over in his mind he resolved to prepare an attenuated anthrax virus, by growing its culture at 42° or 43° C. for eight days. This gave him an anthrax vaccine.

The next step was to test it on animals as a prophylactic. The grand experiment took place in the yard of a farm at Pouilly-le-Fort, near Melun, in the presence of a concourse of friends and critics on May 5th, 1881. Pasteur inoculated 24 sheep, 1 goat, and 6 cows with five drops of a living attenuated culture of anthrax. On May 17th the crucial test was applied. All the 31 animals received a dose of highly virulent anthrax culture, which was injected also into 24 sheep, 1 goat, and 4 cows which had not previously been inoculated with the attenuated virus. By June 3rd all the sheep vaccinated with the attenuated culture were well (except one which died of pregnancy); and the 24 control sheep and the goat were dead of anthrax. The 6 protected cows were well and the 4 unprotected dead. Pasteur's triumph was complete, and he confirmed the value of the experiment by protecting 85,000 other animals in 1881–2, the mortality from anthrax falling from 9 per cent. to 0·6 per cent. By 1894 over $3\frac{1}{2}$ million sheep had been inoculated against anthrax.

From anthrax Pasteur turned to swine erysipelas. By passing its virus through rabbits he introduced a new method of attenuation which provided a vaccine for pigs suffering from erysipelas. His success in providing vaccines for fowl cholera, anthrax, and swine erysipelas encouraged him to attempt the same method for *rabies*. The virus of this disease he and his colleagues found to be present in the central nervous system, and it was readily available in the spinal cord. He took the spinal cord of a rabbit dead of rabies, and attenuated it by drying for fourteen days. By making an emulsion from such a cord, he provided himself with a vaccine. On July 6th, 1885,

a boy of 9 years of age, Joseph Meister, was brought to Pasteur from Alsace suffering from extensive bites inflicted by a rabid dog. Meister was inoculated by small but increasing doses of such a vaccine until July 16th, when he received a one-day dried cord emulsion. He recovered. A second boy, a shepherd from the Jura, named Jupille, aged 15, was similarly bitten by a rabid dog and similarly treated. Similarly he too recovered. By 1886 2,490 persons had been inoculated with a mortality of 1 in 170 treated.

This second great triumph brought a public demand to erect an institution for the production and distribution of Pasteur's prophylactic vaccines, and 2½ million francs were subscribed. The 'Institut Pasteur' was opened in 1888. Pasteur was there, but his work was done.

'I enter it a man vanquished by time. . . . If science has no country, the scientist should have one, and ascribe to it the influence which his works may have in this world. If I might be allowed, M. le President, to conclude by a philosophical remark inspired by your presence in this Home of Work, I should say that two contrary laws seem to be wrestling with each other nowadays; the one, a law of blood and of death, ever imagining new means of destruction and forcing nations to be constantly ready for the battlefield—the other, a law of peace, work and health, ever evolving new means of delivering man from the scourges which beset him.

'The one seeks violent conquests, the other the relief of humanity. The latter places one human life above any victory; while the former would sacrifice hundreds and thousands of lives to the ambition of one. The law of which we are the instruments seeks, even in the midst of carnage, to cure the sanguinary ills of the law of war; the treatment inspired by our antiseptic methods may preserve thousands of soldiers. Which of those two laws will ultimately prevail, God alone knows. But we may assert that French science will have tried, by obeying the law of Humanity, to extend the frontiers of Life.'

He lingered on for several years, always near his new laboratory. He died in his little room of almost monastic simplicity near the laboratory stables at Villeneuve l'Étang on September 28th, 1895, 'the glory of France'. His body was embalmed, received by the Government of the Republic, and accorded a public funeral at Notre Dame. In January 1896 it was laid in the new mausoleum built in the Institute

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itself, after the model of the tomb of Galla Placidia at Ravenna. On the marble walls are inscribed Pasteur's discoveries, and a sentence from his reception oration at the Académie des Sciences:

'1848, Dissymétrie Moléculaire; 1857, Fermentations; 1862, Générations dites Spontanées; 1863, Études sur le Vin; 1865, Maladies des Vers à Soie; 1871, Études sur la Bière; 1877, Maladies Virulentes; 1880, Virus Vaccins; 1885, Prophylaxie de la Rage.'

'Heureux celui qui porte en soi un Dieu, un idéal de beauté, et qui lui obéit—idéal de l'art, idéal de la science, idéal de la patrie, idéal des vertus de l'Évangile.'

Not the least of the services which Koch and Pasteur and their contemporaries rendered to Preventive Medicine was their contribution to methods of investigation, ways and means which have been further extended by their followers to our own day. I have referred already to the outward development which facilitated man's acquisition of knowledge. The invention of printing came in 1440; the Royal Society as an example of exchange and discussion of scientific advances was established in 1660; and there was an immense development of the means of intercommunication and their use. We must always keep an eye on these outward ancillary aids of preventive progress. But the appliances and apparatus used by investigators into the structure of the body were developing concurrently in their own hands.

The microscope had been perfected from the days of Malpighi, Leeuwenhoek, and Kircher, and, even though Bichat largely ignored it, became the one primary essential mechanical aid. J. J. Lister gave us the achromatic lens, and Abbé the condenser. As optical focusing became more sensitive thin sections became advantageous, and these necessitated hardening the tissue to be sectioned, and freezing, embedding, and staining it. So emerged the microtome and the modern methods of histological and bacteriological investigation. If we only consider the present

daily use of the bacteriological methods of diagnosis we shall find how rich a harvest grew from the relatively primitive methods of the middle of the nineteenth century—the collection of samples and specimens at autopsy or clinically (methods of obtaining blood samples, cerebrospinal fluid, faeces, urine, secretions from throat or nose, &c.); culture and isolation media, their preparation, reaction, and sterilization; the ascertainment of the products of cultures outside the body and toxins within the body; the cultivation of anaerobes; incubation, microscopic examination, differential staining; filtration; the examination of sera, inoculation of animals; agglutination, opsonic methods, bactericidal action of sera, haemolytic tests, fixation of complement, filterable viruses, serum diagnosis—how different is all this from Koch's sitting-room down in Posen in 1876, or from Pasteur's little fermentation laboratory at Lille in 1854. When we think of the gift to the world of their discoveries we must not forget their bequest of the beginnings of a new form of scientific method.

The Principle of Immunity

Pasteur used to say that he received part of his inspiration from Jenner's empirical experiments in vaccination. If that be so, Pasteur's own work on the attenuation of viruses was the second great advance which led to the prevention of infective diseases by artificial inoculation. True, he had seen the effect of vaccination in variola, but it was reserved for him to interpret its *modus operandi* and its wide application in Nature to other diseases than small-pox. And he found it a highly complicated and variable process. Natural immunity appeared, no doubt, to be a simple act of Nature. Measles and small-pox do not, as a rule, recur in the same individual, but to find out the secret of natural immunity, and to apply it (whatever it be) artificially to other diseases was far from simple. How well he succeeded in certain diseases we have seen, but as Pasteur saw in his last years, there remained more darkness than light. It may well be that such is the case to-day, yet even in his lifetime 'pointers' emerged. Salmon and Theobald Smith showed in 1884 that

dead virus can induce immunity against living virus, as Haffkine, Wright, and Pfeiffer were to demonstrate along therapeutic lines. Two schools arose: one said that immunity was due to 'antibodies' in the blood-stream and fluids of the tissues, antibacterial, protective or defensive against the bacteria and their toxins; the other school attributed immunity to 'phagocytes' (as Metchnikoff called them), a cellular rather than a humoral protection. First one theory and then the other predominated in the minds of the schools, and many new facts were elucidated by a whole generation of controversy. Out of it, for instance, came the doctrine of 'antitoxins' (Behring and Kitasato, 1890), the standardization of toxins and antitoxins and the difference between active and passive immunization (Ehrlich, 1892 and 1897), bacteriolysis (Pfeiffer, 1894), followed by haemolysis (Bordet, 1895), and agglutination of blood corpuscles as a diagnostic indication (Durham and Widal, 1896).

Space does not allow us here to follow these deeply interesting stages of research. Broadly, what emerged from them was the knowledge that the body is able to generate 'antibodies' of various types in response to the injection of an 'antigen', each group of antigens producing antibodies antagonistic to the specific toxins. The antibodies follow a 'tidal' course and are associated with a corresponding degree of immunity, which though not hereditary, is measurable by the method of serum diagnosis. But the antibodies do not act alone in antagonizing the invading toxin, they are aided by accompanying cellular changes in the body itself. Thus, as Professor Muir says, 'in the development of acquired immunity we see an intensification of actions and properties possessed by the body in the natural state', a condition of immunity which may exist after antibodies have disappeared from the blood, and which is dependent on a high degree of body resistance due to the physiological functioning, dietary, and full oxygenation of the tissues of the body. Here or hereabouts is, as I think, the supreme achievement of modern Preventive Medicine.

The Control of the Tropics

I now turn to the story of the discovery of protozoal disease. Its pathology and prevention are among the achievements of the age in which we live. It opened a new era in the understanding of disease and a new sphere in its prevention. But it did more even than that, for, as Kipling said, it 'made for us a pathway to the ends of all the earth', in other words it began the white man's control of the tropics. There was another thing it did; it proved that the medical practitioner who could comprehend, treat, and prevent the protozoal diseases must himself be a naturalist, like the great practitioners of the eighteenth century.

The application of Preventive Medicine to tropical disease concerns malaria and other fevers; deficiency diseases, such as pellagra and beri-beri; the infective granulomatous diseases, like leprosy; and parasitical diseases such as filariasis, ankylostomiasis, and trypanosomiasis. These are the maladies which have dug the white man's grave in the tropics. Until modern times little or nothing was known of their causation or prevention, and there was a hopelessness about prognosis in all of them. But in the last fifty years immense progress has been made.

Some of the early workers connected with the Indian Medical Service, such as Vandyke Carter, Lewis, and Cunningham, were the originators of search for an explanation of some of the great diseases of the Orient. Vandyke Carter was an assistant surgeon in the Bombay service and set foot in India in 1858, spending thirty years there. He found the spirochaete of relapsing fever in India, proposed methods for segregating lepers, and was one of the first to show that there were three types of Laveran's protozoon in malaria. Timothy Lewis entered the Army Medical Service ten years later than Carter. He described an amoeba in the human intestine, and was the first to discover filaria in human blood in 1872. Cunningham, who was his friend, followed his example in discovering parasites in the bowel, and he became professor of physiology and pathology in the Calcutta Medical College.

These were the men of whom Patrick Manson had heard when in 1876 he found himself for the second time in Amoy. He had constructed in his mind a theory that possibly the filaria was a parasite in the lymphatics as well as the blood, and perhaps the mechanical cause of blockage in the lymphatics, a blockage which might explain lymph-scrotum, chyluria, and the tumours of elephantiasis. So he set to work. He examined the blood of some hundreds of men, and in the first instance discovered that there was a filarial periodicity, that the filaria embryos begin to appear in the peripheral blood towards sunset, increase therein till midnight and then decrease until, at noon, none may be found. Pondering upon this curious phenomenon and realizing that these embryos were the progeny of adult filariae limited to the lymphatics, it became clear to him that they sought the subcutaneous blood for purposes of development, and as they did not develop in the capillaries they must undergo some change outside the human body. This being so, the possibility occurred to him that a free-ranging, blood-sucking insect, such as the mosquito might play the part of intermediate host; for was it not largely a night feeder? and had he not found that the micro-filariae gathered in the peripheral blood at night? He persuaded an infected Chinaman to help him in the verification of his hypothesis, fed mosquitoes upon him and started in to examine them. This is what he wrote about it:

'I shall not easily forget the first mosquito I dissected. I tore off its abdomen and succeeded in expressing the blood the stomach contained. Placing this under the microscope, I was gratified to find that, so far from killing the filaria, the digestive juices of the mosquito seemed to have stimulated it to fresh activity. And now I saw a curious thing. The little sac or bag enclosing the filaria, which hitherto had muzzled it and prevented it from penetrating the wall of the blood-vessels in the human body, was broken through and discarded.'

He had, as he said, 'stumbled on an important fact with a distinct bearing on human pathology'. Then he adds:

'I followed it up as best I could with the meagre appliances at my disposal, and after many months of work, often following up false scents, I ultimately succeeded in tracing the filaria through the

stomach wall into the abdominal cavity, and then into the thoracic muscles of the mosquito. I ascertained that during this passage the little parasite increased enormously in size. It developed a mouth, an alimentary canal and other organs. . . . Manifestly it was on the road to a new host.'

As Alcock wrote in after years, with Manson's discovery of the filaria in a mosquito which had sucked the blood of a filaria-infected man he introduced a new idea into the history of parasitology, 'the necessary intermediation of the blood-sucking insect in an extensive tract of tropical pathology'.

And so it was to prove. When Manson was working at Amoy in China on filaria, Laveran, a French army surgeon, was exploring the parasites of malarial blood at Constantine in North Africa. He it was who in 1880 discovered the parasitic cause of malaria in such a blood protozoon. But Manson did not hear of this discovery for some years, and did not himself see the malarial parasite in the blood corpuscle until 1892 at the Seamen's Hospital at Greenwich, to which, after his return home, he had just been appointed physician. When he did see it, and especially its 'flagellation', he remembered the ex-corporeal stage of filaria. And he dreamed a dream.

He saw in his mind's eye this same malarial parasite in the body of a mosquito, a stage of its existence outside the body of man, and the mosquito the culprit in its spread, as in filaria. Now in the spring of 1894 there walked into Manson's room in Queen Anne Street a young officer of the Indian Medical Service named Ronald Ross, keen on the study of malaria, and to him Manson expounded his dream, and Ross afterwards declared, 'I have no hesitation in saying it was Manson's theory, and no other, which actually solved the problem' of malaria. But it was Ross who was to work it out, and prove it. This he accomplished in three years of toiling research.

In 1897–8 the metamorphosis of Laveran's protozoon was revealed. It has an asexual cycle in the human subject and a sexual cycle in the body of the mosquito. A malaria-carrier mosquito conveys the parasite by its bite to the

blood of man. In man's blood the parasite (sporozoite) penetrates a red corpuscle, grows and multiplies, feeding on the corpuscle, until the corpuscle bursts and the liberated progeny (merozoites) enter the blood-stream and attack other corpuscles. In addition to these asexual forms, some gametocytes are produced, which remain sexually inactive until the blood is shed or sucked into the body of a blood-sucking mosquito. Then they develop in the stomach of the mosquito, the female awaiting sexual contact with the male parasite; the male producing 'flagella', by which it enters the female parasite, which when fertilized becomes a zygote. The encysted zygote in the stomach of the mosquito divides within seven days into a number of sporoblasts and these into sporozoites. When fully developed the cyst bursts, and some of the sporozoites find their way into the large veno-salivary gland of the mosquito, and thus pass into the blood of the human subject next bitten by the insect, and in turn attack the blood corpuscles of his blood, probably setting up malaria in ten days in a non-infected person. The malaria parasite has different forms, which set up benign tertian fever, quartan fever, and subtertian fever.

This is the Manson-Ross interpretation of malaria, now well established. It represents the greatest advance in our understanding of malaria, and provides means for its prevention. The species of mosquito 'incriminated' in this morbid process is the *anopheles*. Prevention consists in destroying it and its breeding places (stagnant pools), in protecting man from its bites, and in giving quinine or other drug which antagonizes its presence and activities in the human blood. Hence has arisen an anti-malaria regimen or campaign consisting of drainage of mosquito breeding places, mosquito netting, screened houses, quinine administration, &c.

Malaria is but an illustration of the scientific attack upon yellow fever, also a mosquito-borne disease, filariasis (conveyed by culex mosquito), sleeping sickness (caused by the trypanosome conveyed by the tsetse fly), or relapsing fever (treponema conveyed by louse or tick). The history of

Preventive Medicine has few chapters so bright as that which concerns the diagnosis and prophylaxis of tropical disease. The stamping out of yellow fever on the Panama isthmus by Surgeon-General Gorgas is one of its triumphs.

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IX
THE APPLICATION OF DISCOVERIES

Synopsis of Lecture IX

The position of English Medicine in 1931 as compared with 1831.

Conservative Medicine comprises the cultivation of the natural defences of the body (the internal environment), the avoidance, prevention or modification of disease-producing factors, the reduction of the sequelae of disease by its arrest, and the provision of a favourable external environment.

The effect of the Darwinian interpretation of natural selection (*Origin of Species*, 1859), has been to make man aware that he is a part of Nature, and that heredity, variation, natural selection, and environment directly concern him.

I. The improvement of medical practice. Diagnosis, differential diagnosis, and ascertainment the first step in Preventive Medicine. The exploration of disease in the individual fortified by new methods (instruments of precision, illumination and measurement, and laboratory investigation). Immunity. Natural, acquired, or artificial immunity, general or autogenous vaccines: small-pox, anthrax, cholera, plague, typhoid, rabies, diphtheria. 'The physician is now an immunizator.'

II. The modern public control of the channels of infection (personal contact, water-supply, food, occupation, schools, housing, sanitation) associated with social betterment, and improved nutrition.

III. The application of Physiology to Industrial well-being.

IV. Anaesthesia. Humphry Davy, 1800, Hickman, Morton, Simpson. Effect on Surgery and on public opinion.

V. Principle of Antisepsis. Semmelweiss. Lister, 1865. Effect on Surgery and midwifery, on disinfection, and on cleanliness of the human body and its surroundings.

IX

THE APPLICATION OF DISCOVERIES

We have now seen how the foundations were laid for the new medical Renaissance in which we live. As we look back to the early ages of magic or witness the long procession of events which mark out the path of scientific progress in Preventive Medicine, we cannot fail to recognize the bridging of the gulf between the past and the present. There has been something more than a steady progress in the growth of knowledge from Harvey to the present day. *There is now a different kind of knowledge.* It may well be true that it is not sufficiently availed of, and not yet fully understood. But it is there. The scientific method of Harvey and his disciples has furnished us with an altogether new apprehension of the healing and preventive powers of Nature and of the latent capacity of man's mind to investigate them and apply them.

Let us, as the motor mechanic says, assemble the parts. We are alive together to-day in 1931. What was the position of Preventive Medicine a century ago? The great Reform Bill was passed in 1832, and though an end-result, it opened the expanding epoch of the new time in which we live. In the science and art of Medicine it found us in possession of the basic elements of a rational anatomy and physiology, and a new understanding of clinical practice became possible. The processes of disease were coming steadily into view, and instruments of precision, such as the thermometer and the stethoscope, had been invented for their elucidation. By that time also empiric methods of prevention were proving effective. Out of the eighteenth century there came an appreciation of the means of protection from disease in selected communities, the army, the navy, and the worker in the mill; safer midwifery was made available; a direct prophylactic had been found for scurvy; and the establishment of vaccination against small-pox opened a wide door towards immunity. These were vital things and had a great progeny. The Reform Bill was the initiation of

a movement by the State for the better communal organization of the nation, and it led up to such agencies as notification of the occurrence of birth, disease, and death, the isolation of the infectious sick, extended hospital accommodation, the medical care of the poor, and the sanitary improvement of the environment of the home and the workshop. Yet the annual death-rate in England and Wales just before the Reform Bill (from 1813–30) was approximately 25 per 1,000, as compared with 12 per 1,000 to-day; and the expectation of life at birth was approximately forty years, as compared with fifty-seven years to-day.

Something profound and far-reaching must have happened during the hundred years that have elapsed between that time and the present to produce a revolution so vast and an extension of human life and well-being so great. Speaking generally, three things happened. First, there has been a century of prosperity. The Industrial Revolution, with all its evils, made England wealthy, and its inventions and the trade they produced brought an immense development in the amenities of life.

Consider how the inner and domestic life of the people has been effected by the following series of social changes since 1830. We will take them in chronological order. The railway and the steamship, the Factory Act of 1833, the abolition of slavery in the British Empire, the telegraph, the reformed Poor Law of 1834; photography, the penny post, the first co-operative society, the Repeal of the Corn Laws, the cheap newspaper, and the ten hours Bill; the great exhibition of 1851, which opened their eyes, for it was something which they saw; the international association of working men in 1864; the Elementary Education Act of 1870, the beginning of free and universal education; the telephone, the phonograph, the internal combustion engine; the use of aluminium; the Workmen's Compensation Act of 1897, the establishment of old age pensions in New Zealand, the women's suffrage movement, and the People's Budget; the discovery of radium and the X-ray, and the invention of the aeroplane and of wireless. There is no mention whatever here of Medicine, yet how deeply and

continuously these changes have altered the physique, social life, and well-being of every man and brought him his food.

Secondly, and concurrently with these events, there has been a further opening of man's mind. Not to speak of the effect of the Reform Bill itself, there were the writings of Carlyle, Goethe, and the Victorian poets and leaders. And there was Darwin. No man has ever changed human thought on the same scale as the author of the *Origin of Species* (1859). The vast mass of men did not read his book or understand exactly what he was talking about. But he led them, almost unconsciously, in a new and strange path, the path of awareness of an ever-widening and deepening interpretation of the natural development of both man and the lower animals. From Darwin every man learned, in a way and degree he had never learned before, that he was a part of Nature, and subject, like his dog or his canary, to the natural laws of *heredity*, of *variation*, of *natural selection*, and of the effect of his variable *environment* on his body and character, their upbringing and cultivation.

Improvement of Medical Practice

It was into this growing world that there came the discoveries and advances of Medicine, a third influence of the last hundred years, and the one with which we are directly concerned. Its particular interpreter is inevitably the medical man. I want you to contrast him with his primitive ancestor of long ago. His patients ask of him to-day precisely the same questions as were asked in the dim past of the early medicine-man. (1) What is the matter with me? (2) Can you put me right? (3) How did I get it? (4) How can I avoid it in future? The questions are as old as mankind. But to-day in England the answers may be very different from those of the ancient magician, for the improvement of medical practice and personal health is one of the signs of the time. It can be measured in many ways, and perhaps the best way is by its results. The English people are healthier, and their span of life is longer, than

at any previous time in their long history. The patient of to-day knows more, can receive earlier and better diagnosis, better treatment, more accurate prognosis, and fuller preventive advice than in 1832.

Another way in which we may estimate the change that has taken place is by comparing the standard text-books, the current medical literature. Sydenham's *Practice of Physic* was published in 1693, four years after his death. It had a currency in England for a century. It was left as a legacy and guide to his medical son, and consists of sections dealing with sixty-one morbid conditions—their symptomatology and therapeutics, with the long-winded prescriptions of Sydenham's day, a practical vade-mecum of Hippocratic and Arabic advice, done into English. Some hundred years later William Cullen, the famous professor of Medicine at Edinburgh, published in 1784 a similar but much bigger book entitled *First Lines of the Practice of Physic*. It is an elaborate system, for his day was one of systems, giving 'instructions for discerning, distinguishing, preventing, and curing disease'. It contains the doctrines and notions of the eighteenth century as to the clinical character and pathology, as then known, of disease. Cullen reviews medical principles from the days of Hippocrates (460 B.C.) to his own time. But he says not a word of Morgagni, whose monumental and revolutionary work on pathology was published in 1761, twenty years before Cullen wrote his book. This is what he says about Hippocrates:

> 'His writings, or those imputed to him, are extremely dissimilar and unequal; they present us sometimes with reflections which discover sagacity, but they are hardly anywhere well considered or digested, and very often discover a childish frivolity. They certainly contain many useful facts and some just conclusions drawn from them; but both these are probably disfigured by such chasms and interpolations as have happened to every ancient writing, and at best they are chiefly local, relative to Greece only.'

This shows how little Cullen had appreciated the sources from which two of his heroes, Galen and Boerhaave, had derived their learning. He summarizes his doctrine in 1784 by concluding 'that the human system can only be viewed

in these three respects, that is, as a *chemical mixt*, as a *hydraulic machine*, and as an *animated nervous frame*. I consider our system of physic to be now complete as to the parts which it ought to comprehend'. Cullen's book was the standard of his day and remained authoritative for sixty or seventy years.

A new, large, and comprehensive text-book on the *Practice of Physic* for 1931 lies before me. I choose it because it is the latest issued. It consists of two volumes containing 1,200 pages, and it carries the imprimatur of the names of three distinguished and representative medical men. All the pompous doctrines, notions, and theories, formerly fashionable, have wholly disappeared. It is a simple and practical treatise of current knowledge concerning the clinical character, the physiology and pathology of the morbid process going on in the patient. There is the differential diagnosis and treatment of each condition, though set prescriptions are few and far between. It is Hippocratic. There is little treatment here that does not purpose to call out the latency of the resistant powers of the body. We are living in another world from that of Cullen. The authors seem always to ask themselves, how is this disease caused and what can be done to prevent it?

Now let us consider for a moment what it is that gives this book the Renaissance touch and the Greek spirit. First, there are brought to the patient's condition new diagnostic methods, a thorough exploration, a research purpose, which did not obtain in 1832: Instruments of precision, illumination, and measurement, laboratory tests at every turn (blood, urine, sputum, cerebrospinal fluid, swabs, pus, Schick, Dick, &c.), the clinical thermometer, the laryngoscope, the polygraph, the electrocardiograph, the sphygmomanometer, the spectrum, the ophthalmoscope, the Roentgen ray, the hypodermic needle, photography. Indeed so abundant are the particular methods of diagnosis that specialisms have multiplied. After all, diagnosis is the most important thing, for prevention or remedy. In the second place, the patient is brought into a new realm of treatment. Resort is had,

as in Hippocratic times, to Nature's own methods of healing —rest, fresh air, dietary, exercise, obedience to the wisdom of the body. But there is something more. There are the means of ensuring them. Here are modes of treatment and prevention which bring the resources of modern science to the task: Physiotherapy, heliotherapy, actinotherapy, hydrology, chemotherapy (arsenic, iodine), endocrinology (thyroid, pituitrin, adrenalin, insulin), psychotherapy.

Lastly, the book is penetrated with prophylaxis and prevention. The physician is definitely concentrating on the preventive aspect, even his remedies are inspired by the preventive spirit. He shows how it can be applied, in migraine and in goitre; in endocarditis and chronic myocarditis; in arterial hypertrophy and hyperpiesis; in rhinitis, broncho-pneumonia, and asthma; in habitual constipation and dyspepsia; in the psychoneuroses; in rickets, rheumatism, and arthritis; in morbid blood conditions, in scarlet fever, tetanus, diphtheria, tuberculosis. There was nothing at all like it in Cullen's day. But the modern physician goes farther. He uses bacteriology as an aid to diagnosis, prognosis, and treatment. He appreciates the processes of infection and watches its channels. He guards against cough spray, droplet infection, 'carriers' bacilluria, and provides accordingly. He swabs throat and nose, and checks incidence and progress by bacteriological findings. *He is also an immunizator.* He takes the new work in immunology of which I spoke in the last lecture, and he bends it to the prevention of disease. He builds up the natural immunity of the body by increasing its powers of resistance by physiological living; and he supplies by artifice an acquired immunity. He uses, as a matter of course, classical vaccines now at his disposal—against anthrax, small-pox, cholera, plague, typhoid, diphtheria, and rabies —but he multiplies them a hundredfold by autogenous vaccines for an ever-increasing group of maladies—in rhinitis and the common cold, in asthma, in dysentery, in cystitis, in pneumonia, in goitre, in anaemia, in rheumatic endocarditis, and indeed in any process which he finds to be infective. They are not all of equal value in practice;

some may be ineffective. But to express it colloquially, the physician is on the war-path as an immunizator, and we are the witnesses of a vast and rapidly extending practice of prevention, undreamed of a century ago, and unavailable a generation ago.

Control of Channels of Infection: Water and Food

(1) *Water-supplies.* I pass now to another aspect of reform, an example of the application of what has been discovered. *The channels of infection have come under control.* We have seen how Sir John Pringle began medical control of the army, and Sir Gilbert Blane of the navy; we have seen how Lind prevented scurvy and Baker lead colic caused by cider. We will now consider the water-supply.

When the country was agitated by the Reform Bill, it was struck by an even more formidable event, an epidemic of cholera. It came first to Sunderland in the autumn of 1831, it spread north into Scotland and south to London, and in 1832 it was widely diffused. It took toll of 52,000 lives, the dead in England numbering 21,800, in Ireland 21,000, and in Scotland 9,600. 'The needy and squalid suffered most', but the whole people learned within twelve months the extreme danger of insanitation and a contaminated water-supply, as they learned also the characteristics of the disease. It was necessary to establish 'cholera dispensary stations', but nothing much more was done.

Sixteen years passed, and it came again, in 1848. This time it advanced slowly from India and the East like the Black Death in the fourteenth century. It killed 53,000 people in England alone. This is what Farr said about it in the preface to his official report to the Registrar-General in 1849:

'If a Foreign Army had landed on the coast of England, seized all the seaports, sent detachments over the surrounding districts, ravaged the population through summer, after harvest destroyed more than a thousand lives a day for several days in succession, and, in the year it held possession of the country, slain 53,293 men,

women and children, the task of registering the dead would be inexpressibly painful; and the pain is not greatly diminished by the circumstance that in the calamity to be described the minister of destruction was a pestilence that spread over the face of the land and found in so many cities quick poisonous matters ready at hand to destroy the inhabitants.'

This disaster aroused the nation to activity, and a cry for a stricter quarantine. Its only redeeming feature was the inquiry by Dr. Snow, an inquiry which led him to suspect that cholera was due to water-supplies polluted with choleraic discharges. It was observed that in London the epidemic was eight times more fatal among those who drank the water provided by the Lambeth and Southwark Water Company than by any other Company. Now this Company derived their supply from the Thames between Battersea and Waterloo Bridge, at a point where the sewage of two and a quarter million people was discharged into the river. The public outcry led to Parliament passing the Metropolis Water Act of 1852 which required the London Water Companies to abandon the tidal waters of the Thames as a source of drinking-water, and to filter the water they supplied.

On this occasion the epidemic did not disappear as promptly as in 1832, and in the years from 1848 to 1854 the disease remained with us, breaking out afresh in 1854, particularly in Newcastle-on-Tyne and other large towns. In that year the disease caused the death of 20,000 persons, making a total, according to Farr, of 250,000 persons which it killed in the seven years. It was observed in this third epidemic that the disease was localized in 'cholera fields' where the water-supply was most polluted, and among washerwomen infected by washing the clothes of cholera patients. It became obvious that the Act of 1852 had been imperfectly administered.

A fourth, and last, cholera epidemic ensued in 1866. It killed 14,300 people living in 640 districts (more than 10,800 fatal cases in London owing to the drinking of unfiltered water). It was at this time believed that cholera was caused by 'minute living molecules', but it was not until

1883 that Koch discovered the cholera bacillus. The impression created by these outbreaks was deep and incisive, polluted water was the communal channel of infection, and all public water-supplies came under suspicion. A larger degree of central and local supervision of such supplies became imperative and has continued ever since. 'Cholera in England', said Farr in 1868, 'has been virtually subdued.'

But a nation learns slowly. England had received four alarms between 1831 and 1866. From 1863 to 1905, for a period of forty years, the country was to learn of the infection and spread of *typhoid fever* by the same channel. The reports began with inquiries of the medical officers of the Privy Council (before the establishment of a Board of Health) in 1863. Streams at Festiniog; wells polluted by adjoining cesspools or privies; shallow wells contaminated from surface soil; deep wells grossly infected by excreta; public supplies deriving water from filthy gathering grounds, from sewage farms, from cemeteries; drinking-water from contaminated leaking sewers, from poisoned springs, from land polluted by the excremental matter of a hop-pickers' camp, from suction between drainage-pipes and water-pipes—these are but examples of a long series of reports covering hundreds of outbreaks and affecting many thousands of persons. In addition, many such outbreaks have originated in public supplies being derived from polluted rivers, cases exactly parallel with the cholera epidemics in London. Finally, typhoid infection has often occurred from the domestic uses of water contaminated in a house where a typhoid patient was being nursed. It is not surprising that Sir John Simon declared that, 'it ought to be an absolute condition for a public water-supply that it should be uncontaminable by drainage'. These outbreaks had, like the cholera prevalence, the wholesome effect of creating an insistent demand that public water-supplies should be strictly controlled. That such control has occurred, and is now relatively secure, is indicated in the remarkable decline of this disease.

How remarkable that decline has been becomes patent to

everybody by the death returns. While I am quoting figures I will include those referring to other diseases. Here is an impressive table:

	Annual Mortality per Million Persons living (England and Wales).				
	Typhoid Fever.	*Small-pox.*	*Pulmonary Tubercu-losis.*	*Scarlet Fever (under 15).*	*Diphtheria (under 15).*
1871–5	371	392	2,327	2,018	807
1891–5	175	20	1,504	498	896
1911–15	47	0	1,005	185	444
1926–30	9	1	721	55	302

The quinquennium 1871–5 was above the average mortality in typhoid and small-pox, but rather below the average in the other diseases. Making due allowance for that fact, the table demonstrates a great decline in the mortality of all five diseases. Some powerful factors must have been at work. Not forgetting the possibility of biological variation, either in virulence or human susceptibility, I think it is safe to say that the typhoid decline was due to improved water and food supply, to general sanitation and hygiene, and to antityphoid inoculation; the small-pox decline to vaccination and a decrease in the severity of small-pox (the mild type did not, however, become prevalent until 1922); the tuberculosis of the respiratory system to preventive measures of various kinds and great improvement in social conditions; the scarlet fever to decline in severity and preventive measures; and the diphtheria to antitoxin treatment after 1895. There is much here we might discuss. But I must return to typhoid.

The decline of typhoid mortality has been due to various factors. First, the improvement in the quality and purity of drinking-water and food, especially milk; secondly, we must remember that since 1875 there has been much fuller public appreciation of its infectiousness and of the necessity of avoiding contagion; there has also been steady advance in methods of treatment. Thirdly, since the South African War Sir Almroth Wright's antityphoid inoculation has been widely applied, both in war and in peace. During the

South African War (1899–1902) there were in the British army 57,684 cases of typhoid with 8,002 deaths; the mortality was 16·6 per cent. among the men not inoculated, and 8 per cent. among the inoculated. Then, ten years later, we have a return respecting some troops in India in 1909. The Peshawar garrison had an approximate mortality from typhoid of 11 per cent., and the Meerut garrison 26 per cent. But after inoculation the two garrison mortalities were reduced to 0·6 per cent. and 1·7 per cent. respectively. There is one other set of official returns (another ten years later) which ought to be quoted, namely, those of the European War (1914–18). The total number of typhoid cases in the four years, on all British fronts, was 20,139 with 1,191 deaths (with two million more men engaged than in the South African War). Of these deaths 18·3 per cent. occurred in the uninoculated and 4·5 per cent. among the inoculated. The total German army experience yielded 12·2 per cent. mortality among the uninoculated and between 2 and 3 per cent. among inoculated. These figures tell their own story, and it is a plain one.

(2) *Food.* We now know that the infection of typhoid fever may also be spread by milk. It was demonstrated in the nineteenth century that infection may be milk-borne in typhoid, tuberculosis, scarlet fever, diphtheria, sore throat, and enteritis. In 1857 Dr. Michael Taylor of Penrith traced an outbreak of typhoid fever to the milk supply, and since that date a large number of similar epidemics have been recorded. It has been estimated, after study of more than 600 typhoid outbreaks, that 70 per cent. are attributable to infected water, 17 to infected milk, 3 to other infected foods, and 10 per cent. to personal contagion or school infection. We must not forget that typhoid bacilli leave the patient's body in the excreta and urine, and that the bacillus may be retained in the body for long periods after the acute illness ('carriers'). It also appears to be true that a small contamination of milk may lead to widespread dissemination owing to the milk providing a favourable nidus for the growth and multiplication of bacilli. So close may be the relationship between an infected dairyman

and milk that the channels of infection are numerous and varied. The milk may receive infection from personal handling by typhoid patients, as at Penrith in 1857, when an infected family conducted the dairying during their convalescence; from washing milk vessels with water contaminated with the typhoid bacillus (as at Bristol, 1897); from adulterating milk with contaminated water (Moseley 1873); from the dried dust of typhoid excreta (Millbrook 1880); from contaminated clothing (Barrowford 1876); or from cooling milk cans by submergence in infected water (Massachusetts 1892).

Similarly milk may receive and convey the infection of tuberculosis, diphtheria, or scarlet fever. A study of milk-borne disease shows that it is characterized by some particular features. In the first place, milk-borne infection follows the milk cart, the houses visited by the milkman purveying the infected milk obviously being the houses put to risk. At Wimbledon in 1886 the epidemic affected 545 persons, of whom 493 were customers of the implicated dairy, and 52 obtained their milk from other dairies (which may or may not have obtained some of their supply from the same source). Secondly, there is a special incidence upon drinkers of better social position than others, for they drink more milk and oftener, and store it in their houses. Indeed, it was shown at Wimbledon that the more highly rated houses suffered more severely than the low-rated houses. Thirdly, of course, the incidence of infection falls only on the raw-milk drinkers in a family. The sporadic or isolated case of infection, which though not living on the milk-round chances by accident to consume a glass of the infected milk, is a decisive witness. Fourthly, women and children, as heaviest milk-drinkers, suffer most, and as a rule more females than males. Sir Henry Littlejohn pointed out that if and when males over fifteen years of age were largely infected it suggested a milk source. It will, of course, be remembered that scarlet fever and diphtheria are children's diseases, whilst typhoid is mainly a disease of young adults, and an exceptional incidence in this respect might raise a *prima facie* suspicion of milk. Fifthly, the incubation period of a milk-borne infection is usually short, the onset is sudden and the decline of the epidemic rapid. The mortality of milk-borne disease is usually lower than the average mortality for each disease otherwise contracted.

More serious than milk-borne zymotic disease is the presence of the bacillus of *tuberculosis* in milk. Tuberculosis

is one of the almost universal constitutional maladies which disables or destroys human life. In 1871 it killed 70,000 persons in England and Wales, and sixty years later (1930) it killed half that number. It is particularly a disease of adolescence and young adult life, but of the 35,000 who died of it in England last year many were under 15 years of age. It has been estimated that a large proportion, and in some varieties as much as half, of the non-pulmonary tuberculous disease of these children is caused by the bovine type of tubercle bacillus. In a word, it is probable that every year we lose a thousand children under 15 years of age from tuberculosis which they have contracted through drinking milk. As much as 40 per cent. of milch cows are affected with the disease, and from 1 to 2 per cent. suffer from tuberculous udder, which is the source of tubercle bacilli in the milk. Infection usually occurs during the early years of life, when milk forms a large part of the diet and when the child's susceptibility to infection is greatest.

Happily the mortality from tuberculosis has been steadily declining for many years, and the death-rate from non-pulmonary tuberculosis in 1930 was less than half that for 1911. But so long as 5 or 10 per cent. of market milk is liable to contain the tubercle bacillus children are exposed to a substantial risk. Various methods of solving the problem are being followed, but probably effective pasteurization of the milk is the best protection for the consumer, and milk so treated appears to retain its valuable food properties practically unimpaired.

I may mention another example which illustrates the necessity for control of food other than milk, and which was elucidated in the nineteenth century, namely, *shellfish* as a channel of infection. In the last half of the nineteenth century several observers suspected oysters of conveying infection. In 1894 an outbreak of typhoid followed a College supper at the Wesleyan University in the State of Connecticut, U.S.A., where oysters had been eaten, and in the following years a number of medical officers of health in this country recorded cases of similar infection. As a

result the Local Government Board instituted an inquiry in 1896 which was conducted by Dr. Timbrell Bulstrode, who also inquired into outbreaks of typhoid fever following mayoral banquets at Winchester and Southampton in 1902, in which 266 persons were guests, of whom 21 were attacked with enteric and 118 suffered from other illness owing to the consumption of infected oysters. Bacteriological examinations by Klein, Houston, and others demonstrated that oysters and other shellfish fattened on sewage-polluted beds contain sewage bacteria, which could survive immersion in sea-water.

Many other forms of bacterial food poisoning have been traced since bacteriological investigation became general. Probably there has always been a greater or less degree of food poisoning, and the immense extension in the variety of dietaries in modern times may well have contributed to an increase in such outbreaks. So-called 'ptomaine poisoning' has been frequently reported. What particularly characterizes the last fifty years is a development of the ways and means of investigation and the new knowledge of bacterial infection. In 1880 'Welbeck disease' was attributed to the consumption of unwholesome ham. Pork and pork pies, brawn, game pies, corned beef, potted meats, sausages, and an endless array of varied meats have been implicated in one or another form of bacterial poisoning, 'botulism', or Gaertner or Salmonella infections. Thus a greater public consciousness of these channels of infection has been created and many successful preventive measures have been adopted.

Here then we have examples of how *water* and *food* may serve as channels of infection. They do not stand alone, but they illustrate a conveyance of disease-producing germs and signify a new understanding of how disease is disseminated in a civilized community.

The Application of Physiology to Industrial Well-being

Let me give you a third example of the application of discovery to the improvement of physique and the prevention of ill health. It directly affects six million persons in

factories and twenty million workers outside them. It is the most sensible and popular of all the public methods of Preventive Medicine, and is yielding a benefit almost impossible to exaggerate. For it is a benefit which passes the bounds of Medicine and even of health, and affects the industry and prosperity of the nation.

The personal health and physical efficiency of all industrial workers is measurable by two standards—first, that of fatigue, weariness, and exhaustion of the healthy physical faculties and functions of the individual; and, secondly, that of disease. It is not possible always to differentiate these two departures from the normal, or to say when fatigue passes beyond the confines of what is physiological to that which is pathological. It is obvious there comes a stage in the processes of fatigue where recovery in any individual falls short of the diurnal rhythm of rest and work, and its degree or character is so severe as to be, in fact, a form of disease. This truth is necessary to a sound understanding of the problem. We must widen our view and apprehension of the subject of health and disease in relation both to industry and to the personal welfare and capacity for work of each workman. The science and art of Medicine is not restricted to the diagnosis and cure of disease in its gross forms; it includes also a knowledge of how disease comes to be, of its earliest beginnings, and of its prevention. It is, in fact, the science and art of Health, of how man can learn to live a healthy life at the top of his capacity of body and mind, avoiding or removing external or internal conditions unfavourable to such a standard, able to work to the highest power, able to rest to the fullest, growing in strength and in the *joie de vivre*. The new Preventive Medicine must not be understood to consist only of sanitation, of the isolation from the community of cases of infectious disease, of disinfection and outward cleanliness, and of the registration of births, deaths, and other vital statistics.

These are, of course, matters of the first importance. But much more is required. The individual man as an animal—the body in all its parts, the senses and their functioning, the nutrition of the body, its growth and development,

its capacity for work, its powers of resistance—must receive practical consideration. The fight against disease is something more than the closing of its channels of communication, something more than an avoidance of the ways and means of its infection and invasion, certainly much more than a registration of its effects, a record of the morbidity and mortality which follow in its train. The turning point of the battle is elsewhere. The first line of defence is a *healthy, well-nourished, and resistant human body*. And to this end the whole man must be dealt with, for he is something more than animal. His body is in greater or less degree the instrument and expression of emotion, intellect, and will. There is thus a psychological aspect of Preventive Medicine hitherto greatly neglected. Nor is the individual, taken at any one moment, the whole of the issue. There is his life-history, his heredity, his family, his domestic life, his personal habits and customs, his home as well as his workshop. In short, Preventive Medicine to be effective must deal with the man, the whole man, as an individual as well as a member of the community.

Now I have put this to you because we have here a new sort of problem, that of Industrial Inefficiency, which calls for a new kind of solution. It is a solution which is dependent not upon medical discovery only, still less upon medical treatment of actual sickness, but upon the application of the new knowledge of physiology, pathology, and even psychology *to sociology and to industrial administration*.

These were, no doubt, some of the thoughts of the statesmen in the days before the Reform Bill, though they would not have expressed them in the same form. The advent of the Industrial Revolution; the findings of Dr. Percival and Robert Owen and their friends in Manchester as to the deplorable physical conditions of the mill workers; the entrance to the mills of women and children; and the vital importance to the success of trade expansion which depended upon the relation of the man to the machine, were four of the factors which moved statesmen. It was dawning on their minds that the neglect of the well-being of the worker was encouraging industrial inefficiency and waste,

discontent, and perhaps even hostility. They thought in terms of money and social relationship, in terms of politics and Bills and administration, but though they did not know it they were really worried about the greater problem of the *physiological basis of labour*, as indeed of all physical and mental endeavour of whatever kind.

We now know that physical health is the fundamental basis. There must be a proper distribution of function in labour, a correct understanding of the part played by nutrition, by rest, by fatigue, by health conditions, if waste is to be avoided and maximum energy attained. The human being is a finely adjusted physiological instrument, which must no longer be wasted, much less destroyed, by ignorant or wilful misuse. A working man's capital is, as a rule, his health and his capacity to perform a full day's work. Once that is impaired or damaged beyond recuperation, two things happen. First, his whole industrial outlook is jeopardized and he becomes by rapid stages a liability and even a charge on the State. Secondly, if the bodily defence is undermined by stress and strain the man falls a ready prey to disease. Therefore, as these problems concern the future as well as the present, so also they are concerned with the new Preventive Medicine which has as its object the *removal of the occasion of disease and physical inefficiency* combined with the husbanding of the physical resources of the worker in such a way and to such a degree that he can exert his full powers unhampered, and with benefit to himself and all concerned.

At first the health of children in cotton factories was the primary matter for concern. The evils of long hours of work and insanitary surroundings, though they had existed previously, had become accentuated by the aggregation of large numbers of workers in factories and by a marked increase in the demand for child labour. The children were helpless to protect themselves against the demands of the employer for cheap labour and against the cupidity of the parents. That any action was taken was due partly, no doubt, to a fear that the conditions of employment might react, not only on the health of those immediately

concerned, but on that of the nation as a whole. Action was, however, mainly due to the gradual awakening of the political and social conscience which occurred during this period. It was a time, not only of factory legislation, but of educational advancement and of prison reform. The awakening was religious as well as social, and the first Factory Act was concerned, not only with the health of apprentices, but with their 'morals'. It dealt with their education and religious training as well as with their physical welfare. The modern Factory Acts were only gradually evolved; legislation was directed to removing particular evils as they became recognized, rather than to the realization of definite principles, based on a critical scientific examination of the causes of the evils. That progress was slow was due in the main to the strength and character of the individualistic or *laisser-faire* views then held, and to the widespread belief that any curtailment of the liberty of action of the manufacturer must be prejudicial to the national prosperity. More than half a century passed before there was any general acceptance of the principle that the State has both a right and a duty to concern itself with the physical and moral welfare of its people.

The movement of reform expressed itself in two ways. First, there was the individual effort of the more enlightened pioneering employers, and secondly, there was the intervention of the State through its central Board of Health and, subsequently, the factory department of the Home Office.

From the days of Robert Owen, and before his days, down to the present time, there has been a succession of benevolent employers who have made it their business to provide for the well-being of their workers, and have thus set a standard and an example to the State. Wood and Walker of Bradford, who inspired Oastler, John Fielden, who, in 1836, felt he was 'the trustee of the interests' of those he employed, Robert Gardner, of Preston, and others were forerunners in a long line of famous employers who have taken upon themselves the responsibility of the care of their workers. 'We manufacturers', wrote Robert Owen, 'are always perfecting our dead machinery, but

of our living machinery we are taking no care.' The movement began with the reduction of hours of labour, but it now comprehends under the Home Office Orders the whole wide compass of 'welfare'. The medical inspection of applicants, the provision of a nursing staff, prevention of accidents, canteen accommodation, recreation agencies, clubs, swimming baths and playing fields, welfare supervisors, were preliminary agencies for the benefit of the worker. 'It is taken for granted', writes an employer, 'that before any so-called scheme of welfare work can be of lasting good a living wage must be paid, and hours of labour and hygienic conditions must not involve the deterioration of the workers. It must be quite evident that clubs and classes, saving funds and libraries are quite thrown away upon workers who are overworked and underfed.' All through this long period of tardy reform, there was little or no appeal to the actual facts of the relation between the hours and conditions of labour on the one hand and the energy and output of the workman on the other. Yet Sir William Mather was able to write in 1894, 'we seem to have been working in harmony with a natural law, instead of against it. . . . Of this I am assured, that *the most economical production is obtained* by employing men only so long as they are at their best—when this stage is passed there is no true economy in their continued work.'

Secondly, alongside the ameliorative efforts of individual employers, sometimes guiding them, sometimes guided by them, there has been the ever-increasing intervention of the State. For a hundred years the movement has been slowly, with tardy steps, gaining ground. To-day, in the presence of a wide interest in 'welfare', it is important to remember that the foundations had been laid by the good will and foresight of employers for many years. It is no new discovery, either as need or remedy. For a proper understanding of the present situation it is necessary to take cognizance of the past. We may briefly consider the matter under four sub-headings: (1) the hours of employment; (2) factory environment; (3) personal well-being; and (4) the effect of occupation on health.

I may remind you that the first Factory Act, that of 1802, dealt with the 'health and morals of apprentices', and though concerned with the restriction of their hours of work omitted the larger number of employed children who

were not apprentices. As a result of the agitation of Robert Owen this was rectified in an amending Act. But even as late as 1844 the view that 'the longer the hours, the greater the profit' was still being expressed in Parliament and outside it. The struggle for a 'ten hours' Bill lasted from 1830 to 1847 before that limitation was secured in the latter year. Commissions and inquiries followed one another in wearisome succession until 1901. The claims for an improved factory environment proceeded concurrently, but some of the personal aspects of the subject had to wait almost until the European War of 1914–18. Then it became clear that much more must be done than the reforms established by the Factory Act of 1901, and the Police, Factories (Miscellaneous Provisions) Act passed Parliament in 1916. This Act was a stage in a long period of development, and greatly encouraged industrial welfare with statutory authority. The old nonsense about the necessity of long hours to big profits was abandoned, and its place was taken by a much sounder physiological slogan 'without health there is no energy, and without energy there is no output'.

As we have seen, Ramazzini and Thackrah were the pioneers in meeting the problem of the effect of occupation on health. We must learn what happened subsequently and how their 'discoveries' came into application. In 1853 and 1854 were published two reports by Mr. A. G. Finlaison, the Actuary of the National Debt, on the subject of sickness and mortality among members of friendly societies. He showed that the demand for sickness allowances depended, not so much on difference of locality or on the density of the aggregation of the population, as upon the degree of the exhaustion of physical force. This was a financial or 'business' point.

But in 1857 Dr. H. Greenhow, Lecturer on Public Health at St. Thomas's Hospital, made investigation at the request of the Board of Health into the incidence of mortality from lung disease among industrial workers. He found that there existed no fixed relation between the prevalence of pulmonary affections and the size of towns, but that various

causes seemed capable of increasing it, of which occupations and mode of life were the most influential.

'It is well ascertained that the great mortality among grinders and cutlers arises from the irritation caused by the mechanical particles produced during the process of manufacture and received into the lungs with the air in respiration.'

Dr. Greenhow included amongst the direct causes of pulmonary disease, the inhaling of fine dust of metal and the breathing of air polluted by fumes or overheated, habitual exposure to hot and exceptionally moist atmosphere, working in ill-ventilated and overheated factory rooms, vicissitudes of temperature and strained posture.

Under the influence of these medical reports and other confirmatory inquiries, succeeding Factory Acts required employers to make special rules to secure the requisite conditions of cleanliness and health, to provide fans or other mechanical means for the prevention of dust inhalation, to safeguard dangerous machinery or processes injurious to health, and to deal with such matters as the removal of dust or fumes. Other defences became necessary, such as certificates of fitness for employment, periodic medical inspection, suitable working costume (overalls, respirators, &c.); provision of canteens or messrooms, surgical clinics, dentistry, and convalescent homes; washing and cloakroom accommodation; the notification of certain diseases contracted in the factory or workshop, including those arising from lead, phosphorus, arsenic, mercury, or anthrax, or conditions leading to toxic jaundice; supervision of home-work was required, and a woman might not be employed within four weeks of giving birth to a child.

Here ended a great argument. Physiology had found its way into Acts of Parliament. The State had not only recognized, at long last, that it had a duty in respect of physiological and pathological fatigue and the high incidence of sickness and premature mortality among all industrial workers, but also that, in order to safeguard the life and enterprise of its people, it must prevent such conditions arising.

The Preventive Value of Anaesthesia

When Jenner was finishing his memoir on vaccination at Berkeley in 1795, Dr. John Borlase, a surgeon-apothecary at Penzance, wanted an assistant, and he took a local young man of parts named Humphry Davy, aged 17 years. The new employee proved to be diligent and after he had concluded his day's work in the dispensary he studied in his own room or on the seashore. The French aristocrat and man of science, Lavoisier, had inspired the youth to pursue philosophy and medicine. So he read all he could lay his hands on, and both the knowledge and habit stood him in good stead. In 1798 Dr. Beddoes of Bristol, with whom he had corresponded on chemistry, invited him to come as assistant in his Pneumatic Institute, the object of which was 'to give fair trial to the medicinal effects of different gases', with a view to their use in the treatment of lung disease. Accordingly Davy left Penzance and did 'experiments' at the Bristol Institute, residing at Clifton. He fulfilled his contract by giving 'fair trial' to the effect of nitrous oxide on himself and small animals. For himself he found that unconsciousness followed its administration. This was in April 1799. Sometimes he was supervised and advised by Dr. Kinglake, sometimes he acted on his own responsibility. In the following year, at the age of 22, Davy published his first paper on *Researches Chemical and Philosophical concerning Nitrous Oxide and its Respiration*; and this is what he says:

> 'As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place.'

Davy moved to the Royal Institution in London in 1801, and next year became professor of chemistry. He invented the safety lamp, was President of the Royal Society (1820–7), and was made a baronet, dying at Geneva in 1829 at the early age of 51. He was the friend of Dr. Brocklesby, Dr. Thomas Hodgkin of Guy's Hospital, and Sir Walter Scott. He was the first to demonstrate the anaesthetic property of nitrous oxide.

In the year of the publication of Davy's first paper there was born, at Lady Halton near Ludlow, Henry Hill Hickman. After becoming qualified he practised in Ludlow, Shifnal (where Dr. Beddoes of Bristol was born in 1760), and Tenbury. In 1824 Hickman published a pamphlet on 'suspended animation', containing his experiments on the inhalation of carbonic acid gas by dogs and mice, which rendered them unconscious, and when in that condition he performed successfully minor operations upon them. 'I feel perfectly satisfied', he wrote, 'that any surgical operation might be performed with quite as much safety upon a (human) subject.' He failed to get his work approved by the Royal Society, and died a disappointed man in 1830.

Twelve years later Dr. Long used ether for minor surgery in America, and he was followed by Wells, a dentist in Connecticut who used nitrous oxide, and Morton (1846) who used sulphuric ether at the Massachusetts Hospital. Finally, Sir James Young Simpson used ether, and also demonstrated the anaesthetic power of chloroform. The effect of these discoveries upon medicine and surgery was remarkable in various ways. Anaesthesia made surgery safer and more popular. The operator could take his time, and therefore perform operations which hitherto had been impossible. The period of sleight-of-hand and lightning surgical feats was over. Deliberate and careful surgery was practicable, even in what were formerly inaccessible sites. Similarly in midwifery pain was relieved and delivery shortened; and in research the worker also could anaesthetize the animal upon which he experimented. It is not surprising that what Weir Mitchell called the 'death of pain' should be hailed as one of the great discoveries of mankind, and should be universally adopted when necessity requires. Its discovery may be said to have been empirical and indeed almost accidental, and the discoverers must be more numerous than we know. It had been long foretold, from the age of Dioscorides and probably earlier, yet it came to be practised widely only after the middle of the nineteenth century. It is needless to add that anaesthetics are now administered thousands of times daily, and

that their vogue has enormously advanced surgical intervention, and thus been the means of the universal extension of preventive surgery.

Lord Lister's principle of Antisepsis

The conquest of sepsis is a very different story. Many physicians and surgeons, long before Semmelweiss, had bemoaned the loss of their patients owing to 'hospitalism', putrefaction of wounds, and hospital gangrene. In 1846 Semmelweiss was an obstetric assistant in the Lying-in Hospital at Vienna, which admitted 7,000 women a year. In one part of the hospital medical students were admitted for educational purposes, in the other part they were excluded. Semmelweiss observed that in the former section the maternal mortality owing to sepsis was 10 per cent. of the cases, sometimes being as high as 20 or 30 per cent. In the other section where midwives alone were in attendance the mortality in childbirth was 3 per cent. One day a surgical colleague died from septicaemia following an autopsy, and Semmelweiss recognized that the condition was similar to death from puerperal fever. When he drew attention to these observations he incurred the displeasure of some of his colleagues and left Vienna. In 1861 he published his book on the Prevention of Childbirth Fever, in which he established that blood poisoning might follow the contamination of wounds, and that mismanagement of childbirth might in this way result in death from sepsis. Semmelweiss died of blood poisoning in 1865 at the early age of forty-seven years.

It was in that same year, 1865, that Joseph Lister proved the validity of his antiseptic principles. He was born in 1827 of Quaker parents, his father Joseph Jackson Lister being the inventor of the achromatic lens, receiving the F.R.S. when Joseph was 5 years old. The boy went to Quaker Schools and afterwards to University College, London. In 1852 he worked at Edinburgh as house surgeon to Syme, whose daughter he married, becoming in due course lecturer on surgery in the extra-mural school. In 1860 he was appointed Professor of Surgery at Glasgow, returning to the Edinburgh professorship in 1869. It was

during his occupancy of the Chair at Glasgow that he enunciated his discovery. After eight or nine years in Edinburgh he accepted the professorship of clinical surgery at King's College, London, entered upon a London practice, and became Surgeon to Queen Victoria. Sir Joseph Lister was President of the Royal Society in 1895, was raised to the peerage in 1897, and died in 1912. This is not the place to describe the life of this pre-eminent man, but I must say a few words about his chief work.

Lister did not 'happen upon' his surgical principles. He arrived at them only after immense toil, persistent study, and meticulous investigation. He was a naturalist, and began by a physiological study of the muscular tissue of the iris and skin, followed by a minute exploration into the early stages of inflammation and the coagulation of the blood. But he pondered for long upon the suppuration of wounds as he saw it in Syme's wards and in the Glasgow Infirmary. It led him to conclude that decomposition caused suppuration and wound infection did not occur without suppuration; that decomposition was, in some unexplained way, set up by air; yet that air alone did not give rise to decomposition. At this juncture he heard from Professor Anderson of Glasgow of Pasteur's work and learned that putrefaction was a fermentation set up by microbes carried in the air, and that it was possible to free the air of these minute organisms. This produced a deep impression upon Lister because he saw at once what an important bearing it might have upon the question of suppuration and wound infection. He now modified his former creed by adding—and micro-organisms cause putrefaction and reach the wound through the air. He saw that he must exclude them from the air around the wound or destroy them in the wound; whence came his use of the carbolic spray and the carbolic dressing. It is now common knowledge that Lister was soon able to control the sepsis of his patients' wounds. But to perfect the application of his principle called for prolonged investigation into the bacteriology of fermentation and of wound infection. His work was not accepted at first, and he was involved in

many controversies, but before the end of the eighties of last century his principles were universally adopted.

The effect of Listerian surgery was to reduce both the incidence and mortality of wound sepsis. It made surgery safer; it reinforced the principle of disinfection; it cleaned up the hospitals throughout the world; it immensely enlarged the scope of abdominal, uterine, and brain surgery; it made surgery more preventive; it saved tens of thousands of lives in peace and in war; and it proved a master example of the scientific method.

Owing to the discoveries of anaesthesia and the antiseptic method, surgery has been revolutionized. It stands in the vanguard of Preventive Medicine. All too often attempts have been made to exclude it, but only by those, I submit, who have misunderstood the basic principles of the preventive sphere of Medicine. Surgery not preventive? Why not? Circumcision has been practised for some thousands of years, and became after long centuries a religious rite, but did that make it less an example of preventive surgery? Surgical intervention in obstetrics is preventive in purpose; the removal of adenoids and suppurating tonsils is likewise preventive; orthopaedic surgery is preventive; and there is the preventive surgery of sepsis, of tuberculosis, of venereal disease, and of much abdominal, gynaecological, genito-urinary, and dental disease. Obviously successful surgery is designed to be curative, but on reflection it will be found irresistible to recognize its prophylactic and preventive tendency, a tendency due in large measure to the immortal work of Lister.

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X

COLLECTIVE AND COMMUNAL ORGANIZATION OF PREVENTIVE MEDICINE

Synopsis of Lecture X

Advance in medical knowledge and the evolution of State action (individualism and collectivism).

How England learned by collective citizenship to control disease.

The organization of the Medical Profession—early forms of incorporation, Medical Act, 1511, foundation of College of Physicians, 1518, first pharmacopoeia, 1618, commencement of organized medical teaching in hospitals, 1726, medical societies, foundation of College of Surgeons, 1800, medical education controlled by statute, 1858, the General Medical Council.

The organization of a State Department of Health. The Manchester Board of Health. The Reform Bill, 1832. (Poor Law Amendment Act, 1834, and Municipal Corporations Act, 1835.) The Board of Health, the Privy Council, the Local Government Board, the Ministry of Health. The Local Sanitary Authorities, with a special preventive officer, the Medical Officer of Health. The Registrar-General. Acts of Parliament, orders, regulations, bye-laws. Public inquiries.

The Public Health Service—

(*a*) Nuisances, quarantine, port sanitation, water, air, food, workshops, housing, sewerage, infectious diseases, vital statistics.

(*b*) Public medical services, maternity, infancy, child welfare, the school medical service, tuberculosis, cancer, rheumatism, venereal disease, mental deficiency; the Factory Acts, industrial welfare; Health Insurance; immunity, public hospitals, international health, research, education in health.

Advance of Humanism in medical social reform: Mead, Sloane, Fothergill, Rousseau, Howard, Wesley, Adam Smith, Bentham, Cobbett, Malthus, Tuke, Shaftesbury, Mill, C. Booth, the Webbs.

Extension of State education (before and after 1870) and industrial economic power.

X

COLLECTIVE AND COMMUNAL ORGANIZATION OF PREVENTIVE MEDICINE

We have now to consider how the advances in our knowledge of Preventive Medicine have been turned to account. What has been done, and what can be done, to use and apply this knowledge to the betterment of man's estate? There is, it is clear, an earlier question to which we must first find an answer. What are, in fact, the fundamental discoveries upon which we can construct effective Preventive Medicine? A moment's reflection will show us that they are not the mechanical, administrative, or technical conveniences which surround us as part of the outward organization of the Public Health Service; it is not only the registration of sickness and death, not hospital isolation or accommodation, disinfection, ventilation apparatus, sanitary contrivances, water engineering, sewage treatment, or housing. These things are no doubt good and essential in their way. But they are incidental to or consequential on something else. Can we extricate from the vast accumulation of medical knowledge which the centuries have provided a few great *principles* upon which to build? I think we can.

The Greeks of the fifth century before Christ were naturalists. From them we have seen the search for the true *Nature of Man*, what his life consists of, what its capacity and power is, as well as its inspiration in ideals of truth, reason, beauty, and goodness. Plato was the philosopher who taught men these ideals; Aristotle the biologist who set men thinking in an orderly way of man's body. Man's own earliest conscious knowledge showed him that he was like his parents both in species and in individual physical character, indeed he recognized he was part of them and part of his ancestors. From the earliest time he also saw that his surroundings affected him more than anything else. Darwin put these early and traditional thoughts of men into some sort of order. He explained that *heredity*, with *variation*, made man what he was at birth, and that

nurture and *environment* were the two principal factors which affected his subsequent character and survival. We can say at once that all true Preventive Medicine must be biological in foundation. Ever since that day, from Aristotle (300 B.C.) till now (1931)—more than two thousand years—mankind has been building, sometimes diligently and sometimes slothfully, his knowledge of man's body and its limitations and powers. We are still at it and must remain at it. For it is the body of man we must study. Biology, which includes physiology and psychology, is still, and more than ever before, the foundation of Preventive Medicine. There is one other thing we may keep in mind. Harvey's demonstration of the circulation of the blood began a new understanding and gave a new direction to that study. It was more epoch-making in that study than anything that had happened since Aristotle. It generated energy, so to speak, and put life, scope, and purpose into human biology. It brought us to see that *function* is the supreme criterion of Nature.

Now, accepting the biological background of heredity, environment, and variation, what are the contents of knowledge which lie at the foundation of Preventive Medicine? I have often pondered upon this theme, and the answer which I offer you can only be tentative, provisional, and incomplete. But it is something we can be going on with, something for our reflection and upon which we can concentrate. I suggest to you eight broad principles, or rather processes of discovery, which constitute the basis of a rational Preventive Medicine and an effective Public Health Service.

(a) *The Nutrition of the Body, its deficiencies or repletion.* It is true that man doth not live by bread alone, but food is the primary basic essential of life. This is so obvious that we are apt to forget that human health and capacity are mainly dependent upon nutrition—food, air, exercise, rest, effective metabolism—and wide departures from, or deficiencies in, the optimum tend to incapacity, disease, or premature death. This leads me to suggest that the work of Lind and others on scurvy is not only one of the first great outstanding discoveries of modern Preventive Medicine

but represents a fundamental principle of preventive dietetics. It is of primary importance that scurvy, rickets, pellagra, dental decay, osteomalacia, and malnutrition should be prevented to the degree of abolition.

(b) *The inoculation and vaccination experience* of the eighteenth century. Inoculation, as a fine art, the early origin of which is unknown to us, is of course closely allied to vaccination, and vaccination prepared the way to artificial immunity. Organized and intelligent immunity to disease is, I suppose, the greatest single preventive discovery conceived of by man's mind.

(c) *The gaseous analysis of the atmospheric air*. The discovery of carbonic acid gas by Black in 1757; of nitrogen by Rutherford in 1772; of oxygen by Lavoisier; and of hydrogen by Cavendish in 1781, constitute landmarks for all time. Their isolation interpreted the respiration syndrome of lungs, tissues, and blood. A knowledge of the interplay of these gases also enlarged our conception of nutrition and made us see that the mere supply to the body of food was but a part of nutrition, and that oxygen as well as protein and vitamins was needed to sustain life.

(d) *Anaesthesia* was something more than a new pharmacological property or effect of a drug, or a combination of drugs, upon the body. Its modern application opened the door to a vast and ever-growing sphere of preventive surgery. The value and safety of anaesthesia increased men's confidence in Nature and its application.

(e) *The constancy of the internal environment of man's body*. Claude Bernard's daring synthesis has proved itself in the experience of men to be one of the principles of Preventive Medicine. We were bidden by him to be witnesses of the inconstancy and variability of the external environment which is omnipresent around us, and the reaction between it and the constant internal environment of the body—and to be vigilant to control, repair, and improve the former, and fortify the latter. Modern physiology is revealing increasing ways in which the constant internal environment is maintained—a circulating blood, lymph, hormones, temperature, and muscular and nervous regulation.

(f) *The cause and channel of infection.* In 1839 Dr. Farr said, 'Diseases are more easily prevented than cured, and the first step to their prevention is the discovery of their exciting causes'. Pasteur and Koch and their disciples, the bacteriologist, the parasitologist, and the epidemiologist, have made the age in which we live the most brilliant in the history of Preventive Medicine. They have rationalized immunity, and explained it. If Claude Bernard and his forerunners revealed to us the responsive and non-responsive human soil of disease, these other pioneers have disclosed the seed and the sower. They have also given us both the cause and the means of defence.

(g) *Antisepsis.* The means and methods of reducing or removing sepsis in clinical surgery (Lister), in clinical medicine, and in an innumerable variety of domestic or social applications have proved one of the most fertile ways of the prevention of disease or its spread.

(h) *Clinical diagnosis and preventive treatment.* From pre-Hippocratic times some definition of disease existed; but the particular contributions of the eighteenth and nineteenth centuries were the observation and differential diagnosis of disease, the invention of instruments of precision, and special methods of preventive treatment. Thus was attempted the solution of excessive maternal mortality and puerperal sepsis, the reduction of child mortality, chemical poisoning, alcoholism, parasitic morbid conditions, &c.

None of us can look at these eight processes of new knowledge without seeing that they could be otherwise classified and still more easily subdivided. For example, the advocates of Heredity, Environment, Nutrition, and Nervous Regulation as the supreme conceptions which the new physiology has interpreted to the world could readily re-present the case in that form, but there is convenience in setting out the eight categories I have submitted to you.

Be that as it may, I believe it is these principles which provide us both with working directions, and with the basis of a philosophy and a polity in the science and art of Preventive Medicine. We have but made a beginning in their study, and scarcely a beginning in their application.

But it is these tremendous verities—and not Acts of Parliament, regulations, or bye-laws—which lie at the roots of prevention. It is out of the practice of these principles that there is to be produced the healthy life of the individual and the nation. Of the health, capacity, energy, longevity, and defence of the human body, this is the source. We cannot by the full adoption of these principles abolish death, but we can greatly extend the frontiers of life.

But it must be said—and here is a strange thing—that it is not, on the whole, these great discoveries which have laid the foundations of the Common Health, which has more largely been due to better wages, improved education, humanitarian nurture, the reduction of pestilence, and a new way of life. Consider the widespread health effect of such simple measures as cleanliness, dietary, dress, the open-air life and the uses of sunlight, increased leisure, the muzzling order for dogs, ventilation, the decline in the habit of expectoration, and the protection of food.

Non-Medical Aid to Medical Science

Before turning to the question of the social and political ways by which England attempts to control disease, let me remind you how great has been the service of non-medical science to the advance of Medicine. We have, it is true, a remarkable galaxy of medical men from Hippocrates to our own day, but there is a more extraordinary line of men and women who have directly contributed to, or conveyed the findings of, medical learning from non-medical sources. Hammurabi, King of Babylon, Moses, and Assur-bani-pal, stand even earlier than Thales and Pythagoras the Milesians, or that wonderful group of pioneers of science who made the Crotonian school of nature and proved themselves the forerunners of the Hippocratic group. Nor must we overlook the historical commentators, Herodotus, Thucydides, Strabo, and Diodorus Siculus. When Hippocrates died, Aristotle, the pupil of Plato, was 7 years old, but he became the tutor of Alexander, who opened the ancient world to Greek ideas, and indirectly gave us the Ptolemies. The Mosaic Law, the laws of Justinian, and the Koran all

assimilated the medical doctrine of their time. In the Middle Ages there were Bernard of Clairvaux, Thomas Aquinas, and Roger Bacon. The last-named, born at Ilchester in 1266, both carried on the Franciscan tradition and founded the experimental method, thus giving Medicine its incentive to research. Petrarch and Boccaccio have left us a medical legacy of the early Renaissance, and Galileo in his wonderful eighteen years at Padua introduced to Medicine the laws of physics. Not less astonishing was the anatomical contribution of the great painters, Leonardo da Vinci and Albrecht Dürer. Garrison reminds us that 'the development of the physiology of respiration was almost exclusively the work of three mathematicians, two physicists and five chemists'.

Descartes, Hobbes, Bacon, and Boyle left an indelible mark on the philosophy of Medicine, as did Adam Smith and Jeremy Bentham a century later. Charles Darwin, like Aristotle, underwent some medical discipline but never became a medical man, yet he altered the whole biological outlook of Medicine. Half a dozen pioneering botanical herbalists had prescribed the course of biology for the student of medicine, but Darwin brought light and liberty. Above all, there was Louis Pasteur who discovered the germ origin of fermentation and infective processes. To these master thinkers there must be added a hardly less surprising list of names to whom Medicine has been indebted since 1800. Sir Humphry Davy, Michael Faraday, John Dalton, Sir Edwin Chadwick, Helmholtz, Florence Nightingale, Kelvin, Röntgen, Sir William Ramsay, Sir William Perkin, Ehrlich, Madame Curie, and Lord Rutherford. Such a catalogue shows the widening scope of Medicine and its increasing claims upon the instruments, inventions, and discoveries of the collateral and ancillary sciences. 'All sciences gain', said Pasteur, 'by mutual support.'

How England learned to control Disease

England began to learn the necessity of stemming the tide of disease in the days of her famine pestilences. The feudal system was in large degree responsible for her earliest

organization of manors, monasteries, and guilds, and it was through these that she acquired political knowledge and a local sense of governance. The prevalence of leprosy and plague provided a hard school, but, as we have seen, they left an economic and social effect which can be traced back through six centuries. When, after the Renaissance, she emerged into the palmy days of the eighteenth century there had grown up *an English character* which had become stabilized. It possessed some features which were to stand it in good stead. There was a sense of public spirit, a practical capacity, an ever-broadening humanitarianism, and a faculty, almost amounting to genius, for local administration and control of affairs. It was upon such a national character that there came the events of the last half of the eighteenth century. Circumstance rather than philosophy was the moving occasion which gave birth to astounding advance.

The circumstance was the emergence of three series of events of world import. In Britain there was the imperial expansion of England, Clive in India, and Wolfe at Quebec; there was the rise of Methodism, which more closely affected the mass of the people than anything which had happened since the Petition of Right; and there was the Industrial Revolution, which owing to the inventions after 1760 gave rise to the factory system and an industrial age. In America there was the Declaration of Independence, which reiterated the ancient claim of national freedom and introduced into world polity the governing practice of federation of states within a republic. In France there was Rousseau, the social contract, and the Declaration of the Rights of Man, a revolution which demanded Liberty, Fraternity, and Equality, *the reign of democracy*.

So began the mighty avalanche which swept all before it, and which is still sweeping onward and profoundly affecting the conditions under which mankind chooses to live. That is the experience which befell the England of the end of the comfortable and complacent eighteenth century. It was the living witness of the beginnings in the modern world of the arrival of an industrial age, of an effective

local governance, and of the emergence of democracy. The people desired to take a hand in the business.

But we must get down a little closer. For a new ideal arose. Its purpose was to *forsake the individualism* and communal *laisser-faire* of the eighteenth century, and *adopt collectivism*. The history of the transition was told nearly thirty years ago by Professor Dicey in his *Law and Public Opinion in England*. He said there were four changes in social opinion which led to this, (1) the parliamentary conflict between individualism and collectivism which arose out of the new factory movement, and the proposed supervision by the State in default of the individual employer; (2) a changed attitude in the public opinion of the working classes which began with Chartism and ended in a desire for Trade Unionism; (3) the passage of commerce from the small employer to corporate bodies and companies for railways or joint stock; and (4) the unsatisfactory condition of the people, physically and socially, bred intense desire for reform. These influences led toward what was called 'socialism', which even swept Mill into its net, though he was to the end opposed to its extreme forms. But the movements of the day all went eventually in one direction, namely, for *the collective and co-operative organization of the community*. 'It is only by sharing in the collective life of organized societies', wrote Professor McDougall, 'that the mass of men is raised above a very low level of almost purely selfish behaviour; and it is through such sharing that great numbers of men are raised to a level of consistently public-spirited conduct and even to heights of heroic self-sacrifice.'

'The typical figure of the England of the Middle Ages', it has been said, 'was the lord of the manor; the dominant types of the England of a century ago were the improving landlord and the capitalist mill-owner; the most characteristic personages of the England of the twentieth century are the elected councillor, the elementary schoolmaster, the school doctor, and the borough engineer.'

But this is to anticipate.

Out of the reforming zeal for liberty from war taxation and for the public education of Brougham, the utilitarian

and hedonistic philosophy of Bentham (who desired 'the greatest happiness of the greatest number'), the effective socialism of Robert Owen in his Lanark mills, and the agitation-journalism of Cobbett, the English people were led straight to the Reform Bill of 1832. For them this meant three things which they were determined to secure, namely, popular election for Parliament by a wider franchise and the redistribution of seats, the nation itself to govern by democratic rather than aristocratic institutions, and the purpose of government to be the actual betterment of social conditions.

From the Reform Bill of 1832 we can date the profound political changes which brought in their train an enormous improvement in the health of the people. This is not because the Bill contained any public health clauses, but because it almost immediately produced three measures which delivered the goods that the people demanded. First came the effective Factory Act of 1833 (Lord Althorp's Bill) which fixed the working hours of children and young persons, and established factory inspectors; secondly, the Poor Law Amendment Act of 1834 followed. It was inspired by Chadwick the disciple of Bentham, put an end to the systematic abuse of poor law relief, and set up the ill-fated but extremely valuable Poor Law Commission, the first central board concerned with public health, directed primarily to the poor but applicable in the long run to all. Thirdly came in 1835 the Municipal Corporations Act, which readjusted the administrative areas of the boroughs, provided for elected corporations in place of co-optive municipalities, and strengthened local government authority. From these three Acts was to grow up, by extension, almost the whole of the modern statutory services in behalf of the health of the people. It was this machinery which was the vehicle of the new knowledge of Preventive Medicine.

But that knowledge (*a*) had itself to be conveyed and incorporated in some form of medical organization, (*b*) had to be represented in State enactment and local regulation, and (*c*) had to be implemented and inspired by Education and Humanism.

The Organization of the Medical Profession

Here the pioneer was Thomas Linacre, of whom I spoke in the sixth lecture. The remainder of his story may be soon told. Several English physicians in the sixteenth century, who subsequently became leaders of the profession, followed the example of Linacre and went to Padua. The chief among them were Edward Wootten, the biologist, William Gilbert the physicist, John Caius the anatomist, who lived eight months with Vesalius himself at Padua, and William Harvey, who in 1616 demonstrated the circulation of the blood. They all brought back 'the Greek learning', and thus strengthened English Medicine. One of the early results was an immense improvement in medical education, apprenticeship, and clinical teaching at the bedside, which usurped the place of the *Canon* of Avicenna and the *Ars parva* of Galen. By the eighteenth century one or two proprietary medical schools were established (such as the Hunter School in Windmill Street, 1770), and a medical faculty was instituted in the University of Edinburgh in 1726, inspired by Boerhaave of Leyden. In 1617 the Apothecaries received their charter (which thus followed those of the College of Physicians and the Barber Surgeons), and in 1800 the Royal College of Surgeons was founded. It may be added that twenty-two medical schools now exist in eleven English Universities, twelve of them being affiliated with the University of London.

In this way Linacre and his successors were the real builders of a learned profession. But it became evident during the eighteenth and nineteenth centuries that to train medical men in their art was insufficient. Some regulation of medical practice was also necessary. For alongside the properly qualified physician there arose a motley crowd of quacks, bone-setters, prescribing parsons, proprietors of patent medicines, herbalists, alchemists, and mountebanks, with the result that the sick were bewildered. Within the profession, too, there was confusion between approved and unapproved qualifications, between private practice and medical aid societies, dispensaries, club-practice, and abuse

of hospitals. The situation is thus described by Sir John Simon in his *English Sanitary Institutions*:

'The legal titles of medical practitioners were as various as the names of snuffs or sauces. Twenty-one disconnected corporate authorities within the United Kingdom were issuing their heterogeneous credentials of qualification (more or less) for responsibilities in Medicine. The authorities were mainly of medieval root; some in trade-guild sort, some in sorts ecclesiastical. From an authority of the former sort, a man might hold a licence to practise medical or surgical business within particular boundaries; or from an authority of the other sort (perhaps deriving primarily from the Pope) he might be certified to the world at large as an orthodox teacher of medicine, who, if competent to teach, was inferentially also competent to practise; but the licences and degrees did not secure anything like a professional preserve to those who held them; for though in some cases poachers were threatened, there was in effect almost no restriction on practice, and any one who chose might entitle himself surgeon or doctor. The authoritative titles, moreover, were themselves of no settled value; for the State had hitherto not troubled itself as to the terms on which they should be granted, and the qualifications exacted from candidates varied greatly among the title-granting bodies. Of some of the bodies it used to be said that their examiners were of extremely easy virtue; and as the granting of titles was often an important source of income, evidently it was not improbable that the reproach might sometimes be deserved. Against that disorderly state of things, public-spirited members of the profession had long, but vainly, protested; urging that the various medical titles ought to be brought to have real significance; ought, all of them, to guarantee the possession of professional skill and knowledge according to some one common standard of minimum qualification, and ought, under that condition, to carry equal privilege in all parts of the Kingdom. Legislation for purposes such as these could scarcely have been opposed on any reasonable ground; but whenever it had been attempted, the intricacies of parts of the matter, and the antagonisms and jealousies of so many conflicting jurisdictions and interests, had shown a chaos which statesmen in general could only regard with despair.'

Before 1830 questions of medical reform had been raised in Parliament, but it was not until 1858 that the *Medical Act* was passed. Its object was to ensure 'that persons requiring medical aid should be enabled to distinguish

qualified from unqualified practitioners'. It therefore created a superintending and representative body, the General Medical Council, to establish and maintain a Register of qualified practitioners (competent in medicine, surgery, midwifery), and to exclude from it the unqualified practitioners and those convicted of crime or infamous professional conduct.

At the time of the passing of the Medical Act of 1858 the profession in England consisted of some 20,000 qualified medical practitioners. In 1891 this number had increased to 25,000, and in 1931 to 55,000 registered medical practitioners (many of them abroad). A relatively small number of these practitioners were consultants and specialists, an ever-increasing group were associated, part time or whole time, with the expanding public medical services (e.g. army, navy, India, Dominions and Colonies over sea, and the civil public health services of the Empire), and the majority were general medical practitioners.

Now two things happened: first, the rapid growth of the public medical services, which attracted an ever-increasing number of medical officers into their ranks; and secondly, the increasing imposition of statutory duties by Parliament upon the registered practitioner brought directly or indirectly a much closer association of the medical profession with the State. These expansions were due not only to the growth and widening application of the science and art of Medicine but to the still more rapid growth of the civic sense of applied statecraft. And, speaking broadly, this sense was in large degree awakened, in and out of Parliament, by the growing appreciation of *Preventive* Medicine. 'It is the province', said Simon, 'where Medicine joins hands with Common Sense.' The Crimean War and the work of Miss Nightingale, the social movement led by Lord Shaftesbury and others, the medical needs of industry, public elementary education, the spread of Chadwick's 'Sanitary Idea', the South African War, the Workmen's Compensation Act, the imperial necessity of the control of the tropics, the National Insurance Act, and the European War had created a new 'sanitary conscience'.

A moment's reflection will make obvious the exceptional

importance of the Medical Act of 1858; 'the year deserves a white mark among the years of sanitary importance.' For it did this, it organized Medicine to serve the nation, regularizing and defining it as a profession, able to render a greatly needed public service, as well as fulfilling its personal and historic purpose. From that date onwards the State itself was to receive the immense advantages of organized Medicine, and science and healing were to become more available for the benefit of all. But the Medical Council did three other things. First, it was held responsible for advising the licensing bodies as to the character and standard of *medical education and examination* for qualification for admission to the Register. Secondly, an amending Act in 1886 empowered the Council to establish *a diploma in public health*, which was to provide a special qualification in sanitary science for those registered medical men who wished to hold the official position of Medical Officer of Health which had been created under the Public Health Act of 1875. Thirdly, it drew the attention of the whole profession to the essential business of the *prevention* of disease.

I need not here dwell upon the Council's function in respect of medical education, nor its creation of a special diploma in Public Health. Both duties were imposed upon it by Acts of Parliament, in 1858 and 1886 respectively. But we must consider briefly what has happened as to the need for a fuller integration of preventive teaching within the medical curriculum.

How the Private Practitioner undertook Public Duty

This is what has happened. Under the Poor Law Amendment Act of 1834 Parliament created part-time medical posts in the poor law medical service, to be filled by medical men willing and desirous to render such service in addition to their private practice. In due course 2,000–3,000 medical men thus became District Medical Officers for the poor. Parallel with this movement, and under the same Poor Law authorities, there were appointed a similar number of medical men as Public Vaccinators. From 1848 onwards medical men became part-time medical officers

of health, and by 1875 the whole country was divided into sanitary areas with such medical officers engaged in a rapidly expanding public health service. Within a generation a third medical service arose under the Factory Acts and 2,000 medical practitioners became certifying factory surgeons. This was followed by a fourth public medical service, and by 1910 there were a thousand school doctors. Then came a fifth group under the Maternity and Child Welfare Act of 1918, in which 3,000–4,000 doctors are engaged. Concurrently Parliament approved (1912–16) of the appointment of medical officers for public medical services for tuberculosis, venereal disease, and mental deficiency. But this was not all. Between 1874 and 1930 Parliament imposed statutory duties of a *preventive* kind upon *every registered medical practitioner*. He must certify, notify, and justify in various and manifold directions. His liabilities as a certifying officer of Preventive Medicine have become comprehensive—birth, sickness, death; poisonings, vermin, vaccination; nuisances, disinfection, offensive and dangerous trades; inebriates, mental deficients, drug addicts. As Sir Henry Acland said, 'The general practitioner throughout the whole country became connected with a State system of organized medical observation and relief. . . . A new conception of Medicine had arisen throughout the English-speaking race.'

Moreover, quite apart from any statutory obligation, the practice of every medical man has been steadily becoming more preventive. A glance at the standard text-book on Therapeutics, which has been republished thirty-two times since its issue in 1884, will show how profound has been the change, and confirms the development I spoke of in the last lecture. Forty years ago this book almost ignored preventive therapeutics. To-day, its advocacy of prevention is clear and vigorous. 'The art of therapeutics consists in controlling the forces which affect the body injuriously, or in counteracting or neutralizing their actions and effects by other forces, until the body returns to the normal.' Personal and physiological hygiene, preventive medicine, prophylaxis, attention to the cause, limitation of processes

of degeneration, encouragement of reconstructive processes of repair are basic recommendations. 'This is the most extensive and important province of therapeutics and affords opportunities of employing remedies of every kind.' Antiseptics, antitoxins, anti-scorbutics, dietetics, vaccines, serum therapy, insulin—they have all come into routine use. Even the drugs prescribed accord with this new attitude.

We must not overlook the fact that 15,000 practitioners in England have accepted service under the National Insurance Act, an Act passed by Parliament for the *prevention* as well as the cure of sickness. Its preventive value is obvious, for the 15,000 doctors are the medical advisers of 15,000,000 people, more than a third of the whole population and inclusive of all the wage-earners of the country; and these people come to their doctor freely, frequently, undeterred, and for the beginnings of disease, at the juncture when disease may be most effectually controlled. Consider also the widespread and enduring preventive value of special dental and ophthalmic benefits. For the profession, too, the arrangement is an immense and autonomous advantage—no bills, no fees, no bad debts—a very different thing from the old club practice. If a sound prescription possesses any preventive virtue—and we have high authority for believing that there can be no true therapeusis without a preventive element—it must be assumed that fifty million prescriptions a year are not without preventive value.

Thus when the General Medical Council revised the medical curriculum in 1922, it was faced with a score of Acts of Parliament imposing duties of preventive medicine upon the medical practitioner, and it was confronted with the enormous advances of Preventive Medicine in recent years. Accordingly it was resolved by the Council to recommend 'that throughout the whole period of study the attention of the student should be directed by his teachers to the importance of the preventive aspects of Medicine'. This was not a passing fancy or popular stunt. It was an imperative necessity, imposed by the demands now made

upon scientific medicine and the requirements of the State.

'That Medical School which fails to-day to provide liberal instruction in preventive medicine', said Professor Sedgwick of Massachusetts, 'is sending out its graduates unprepared for some of the most serious problems they will have to face in the immediate future.' And recently Dr. Dingwall Fordyce, of Liverpool, has said that 'the benefits which the community can derive from the most comprehensive efforts of a State department are unduly limited unless the whole profession of medical practitioners become the exponents of preventive as well as of curative medicine. It is altogether undesirable to separate curative and preventive medicine, and instruction in preventive medicine must be given to all medical students.'

Whatever benefits we may reasonably expect from organized public health services under the auspices of the State—sanitation, housing, factory laws, food control, school medical service, the prevention of infection, maternity and infant welfare, poor law medical services, international health—the real outpost, the pivot, the interpreter, the exponent of Preventive Medicine, is the medical practitioner. The time is not far distant, if it be not here already, when the 'public' as well as the 'private' patient will demand preventive advice from the practitioner, both in the manifold forms of domestic sanitation, and in personal hygiene and prophylaxis.

The Creation of the Public Health System

We must now go back to the Reform Bill. We saw that it was epoch-making mostly because of its effects, in producing almost at once the Poor Law Amendment Act of 1834. How little did its supporters realize that they were laying the foundation of a public health system that was to cover the country, prolong human life, and become in less than a century the envy of all nations.

A voluntary society, named the Manchester Board of Health, had been set up in 1796 by Dr. Percival and Dr. Ferriar and their friends, to deal with factory hygiene, and bring to the attention of the authorities in Manchester

and Parliament the urgent need of reform and regulation. Four years later there was born in Manchester a child named Edwin Chadwick, who was to enjoy life for ninety years. His grandfather had been a friend of John Wesley and his father was tutor to John Dalton. At the age of 10 his father removed to London, and the boy took to journalism and in due course found himself associated with Dr. Southwood Smith, acting as a clerical assistant to the great and all-pervading Jeremy Bentham. Deeply interested in social and sanitary reform, he soon became enmeshed in Bentham's regenerating schemes, and in 1832 was appointed an Assistant Commissioner for Lord Grey's preparatory inquiry into the Poor Law. When the Amendment Act passed Chadwick became Secretary to the Poor Law Commission set up under the Act, and in this capacity, until his retirement in 1854, he rendered the remarkable service which made his fame. The Commission employed Dr. Smith, Dr. Arnott, and Dr. Kay to inquire into the condition of the English poor, their physical impairment and its causes, the prevalence of disease and its reduction.

This was a new sort of Government action and a new use of medical men, and the results were prodigious, for these same Poor Law reports became 'the public health annals of England', and they roused Parliament in 1840 to institute a general inquiry into 'the circumstances affecting the health of the inhabitants of large towns with a view to improved sanitary arrangements for their benefit'. In 1842 Chadwick and his medical colleagues produced their memorable General Report on the Sanitary Condition of the Labouring Population of Great Britain. It dealt with the social and sanitary conditions found, with the comparative chances of life in different classes of the community, with the pecuniary burdens created by the neglect of sanitary measures, the evidences of the value of Preventive Medicine, and with the enactments necessary to betterment. They found a condition of things which Parliament received with 'astonishment and dismay'. Lord Normanby spoke of his 'horror and incredulity', and Lord Ashley (Shaftesbury) wrote in his diary, 'what a perambulation have I taken

to-day in company with Dr. Southwood Smith! What scenes of filth, discomfort, and disease' (in Bethnal Green and Whitechapel). Chadwick's monumental report proved that there was much infectious disease and gross insanitation, defective water supply, an excess of widows and orphans, 'the loss of working ability among large classes cannot be less than eight or ten years', shortened lives, high child mortality, and all the harvest of the slums. His advocacy led to the Royal Commission of 1843, which confirmed his account of existing evil and most of his proposed reforms.

Sir John Simon said that Chadwick was the first to 'awaken our statesmen of those times to the duty of caring for the Public Health, and the first to bring Health under the protection of the Law'. The immediate result was the appointment of medical men as officers of health and the creation of a central and executive Board of Health, which was at first without a medical member, though in two years time Dr. Southwood Smith was appointed. A sarcastic critic said the Board consisted of 'two Lords and a Barrister to preserve the health of the living; and then, after a year or so of doubtful success, called in a Physician to bury the dead'. The Board did valuable work for ten years, particularly in regard to cholera, and in 1859 was succeeded partly by the Home Office and partly by the Privy Council, under which a medical department was established with Simon as medical officer and a staff of temporary medical inspectors, who produced the well-known series of reports on epidemics, pulmonary diseases, infant mortality, food-supply, housing, sanitary circumstances, and vaccination. Thus Simon was the creator of the present system.

Ten years later, in 1869, a Royal Commission was appointed to review the position. It was inspired by Rumsey and a number of medical and social workers. It had upon it some representative medical men, Sir Thomas Watson, Sir James Paget, Sir Henry Acland, Sir R. Christison, and Sir William Stokes, and Simon, Budd, and Farr gave evidence. Speaking generally, the 1843 Commission found the existence of a serious national evil of insanitation and

SIR JOHN SIMON
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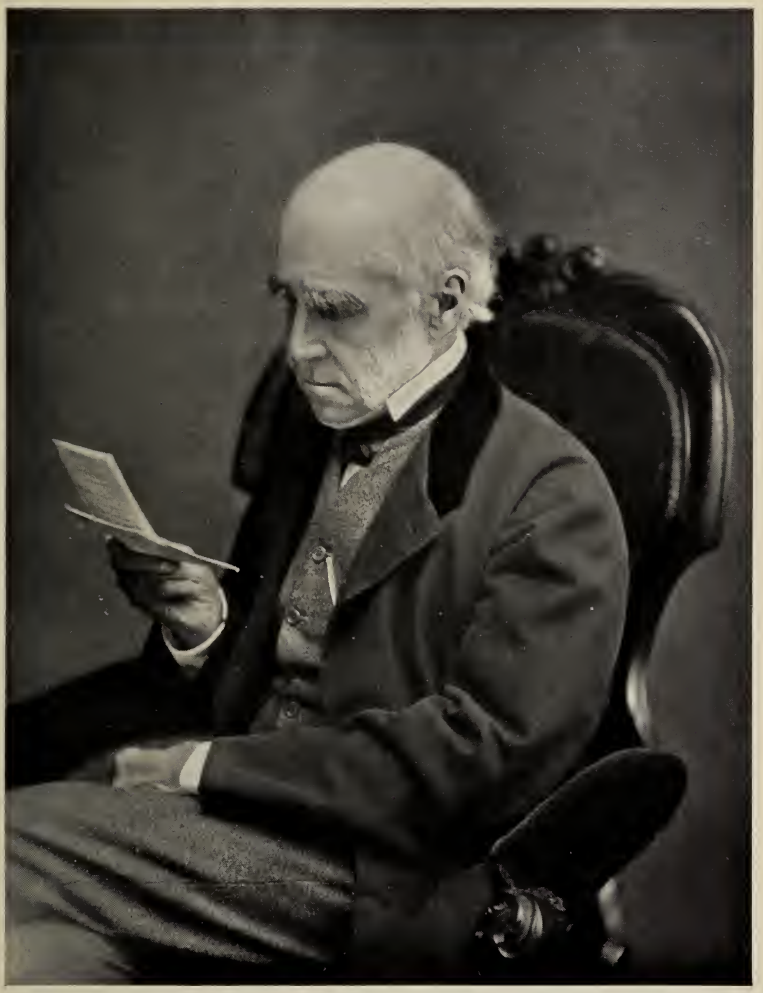

SIR JOHN SIMON

ill health, and recommended legislative remedy, whereas the 1869 Commission found that the remedy had proved ineffective and recommended that 'the present fragmentary and confused sanitary legislation should be consolidated'. They proposed, in fact, for the first time, a Ministry of Health; but the case miscarried and the Local Government Board was created in 1871. The Commission's summary of the national sanitary minimum of 'what is necessary for civilized social life' is the grand inventory of that period. Here it is:

(i) The supply of wholesome and sufficient water for drinking and washing.
(ii) The prevention of the pollution of water.
(iii) The provision of sewerage and utilization of sewage.
(iv) The regulation of streets, highways, and new buildings.
(v) The healthiness of dwellings.
(vi) The removal of nuisances and refuse, and consumption of smoke.
(vii) The inspection of food.
(viii) The suppression of causes of diseases and regulations in case of epidemics.
(ix) The provision for the burial of the dead without injury to the living.
(x) The regulation of markets, &c., public lighting of towns.
(xi) The registration of death and sickness.

Half a century ago that programme represented the most enlightened thought of the time regarding the sphere and scope of Preventive Medicine. Even now it is almost a complete summary of the elements of a sanitary environment. But this prescription was not all the advice the Commissioners felt called upon to furnish. First, they showed how it could be worked out in practice, by laying down the general principles to be followed and by drafting a new statute. Secondly, they diagnosed with unfailing accuracy the causes of imperfect sanitary administration. Finally, the Commissioners lent all the power and prestige of their position and experience in unreserved support of the great principle of local self-government.

The Public Health Act of 1875, which emerged from the

labours of the Royal Sanitary Commission, may be regarded as marking a great advance in the development of sanitary administration. Before that time sanitation was interpreted in large measure as a negative policy, in a word, the removal of nuisances; after that time sanitation received a new connotation, positive, constructive, remedial. That is the reason why this Act forms the great line of division, the watershed, in the progress of modern Preventive Medicine, on its environmental side.

The creation in 1871 of the Local Government Board was succeeded forty-eight years later by the Ministry of Health. Although I cannot here deal with the Ministry of Health, I may remind you that its initial purpose was effective co-ordination. Of all the examples of such co-ordination the most impressive historically is probably the correlation of the two great health Acts, the Poor Law Act of 1834 and the Municipal Corporations Act of 1835, with their progeny, after ninety years of parallel growth, in the Local Government Act of 1929.

The result has been that the demands of the Royal Commission of 1869 have not only been amplified and extended in scope, but revolutionized in comprehensiveness, vitality, sphere, and purpose. They have been enlarged in scope. 'Building regulations and the sanitation of dwellings' have been transformed into a vast *national policy of housing reform and town planning*—a policy which was initiated by the Royal Commission on Housing in 1885. 'The removal of nuisances, the regulation of markets and the reform of the factories and mills' have become the new enterprise of *Industrial Welfare*. 'The inspection of food' has extended to the control of its sources, its analysis and constitution, its preparation, manufacture, and sale. 'The registration of death and sickness' has become a wide system of notification of all infectious diseases and the codification of vital statistics. Thus has the scope of sanitation enlarged.

But its objective also has found a new centre of gravity, for no longer is an improved environment only the goal of the public health. There has followed the care of the person and the worker; the mother, the infant, the child.

Sixty years after the programme of the Royal Commission of 1869 the Public Health Service of the State incorporates its eleven sanitary provisions necessary to civilized social life, but it has been widened to include eleven other forms of State medical aid:

1. The housing of the people and the planning of town and country.
2. Industrial welfare of the worker and supervision of his workplace.
3. The care and supervision of maternity.
4. The health of infants and children, including child welfare and a school medical service.
5. The organized treatment of the common infectious diseases.
6. The treatment of constitutional disease: tuberculosis, venereal disease, cancer, rheumatism, mental deficiency, lunacy, blindness.
7. The provision of the means of such treatment: clinics, hospitals, sanatoria, special schools, training centres and colonies.
8. A national health insurance system, preventive and remedial.
9. International sanitary conventions.
10. Medical research and investigation into causes and prevention of disease.
11. The education of the public in health.

No one can consider these two categories (pages 259 and 261), these two programmes of practical preventive medicine, without observing the collective organization of the principles of which we have in these lectures been discussing the origin. It is not our task to deal with their administration or results. But we see here three interesting things. First, the rise of this knowledge and some of its application belong to a remote past. Secondly, it is a remarkable achievement of co-operation between voluntary services and statutory measures; it represents individualism and collectivism, a sort of 'massed individualism' which in the end won the adherence both of Mill and John Morley. Thirdly, it is an organized expression of the value of the doctor and the State working together, the doctor's share being the use of inductive science interpreted through individualism, the State's share being the application of deductive science by collectivism.

Education and Humanism

The story of the evolution in England of the present Public Health Service was not of course isolated. It was the development of a century. It took colour from the changing times and the ever-changing succession of party governments. Its character was derived from the ideas of statesmen and doctors, inspired by an opportunist policy and the growing knowledge of Preventive Medicine. Its trend was, however, directed by two much wider influences, namely, the expansion and interpretation of *Humanism* and an ever-extending *Education* of the people as a whole. It is impossible to say which, if either, of these forces predominated, for now one and now the other inspired and controlled the occasion. Altruism, evangelicalism, humanitarianism, labour partnership (or trade unionism), co-operation, and insurance express some of the great social and religious movements which have played their part in its growth and development. There was the benevolence and altruism of the medical profession; the evangelical revival of Wesley and the Methodists; the humanitarian ideals of Elizabeth Fry, John Howard, Samuel Romilly, and Wilberforce; 'the greatest happiness of the greatest number' of Bentham; the broad common sense and understanding of Percival, Ferriar, Haygarth, and the medical officers of the Poor Law Commission; the 'socialism' of Owen, Cobbett, Place, and the Chartists; the co-operative movement; Lord Shaftesbury, Chadwick, Simon, and Florence Nightingale; the far-seeing economy of employers; Mill and the utilitarians; and the promoters of national registration and insurance.

And all the time there was the deep undercurrent of demand from a people being steadily educated. Lancaster and Bell found a statesman in W. E. Forster and great after-leaders in Arnold, Butler, and Thring. Universal elementary education—a basic essential in Preventive Medicine—was followed by adult education—a hunger and a thirst for knowledge even if it had to be sought in night-schools and mechanics' institutes—and this in its turn was followed by secondary and university education, by voluntary organizations for adult education reaching half a

million people, by an enormous increase in the publication of books and newspapers, and by the use of the wireless. All this had its effect upon the building of a public health system and of preventive medical services, supported out of the rates and aided by financial grants from the Exchequer.

There is nothing educates a people more than sanitation, and Preventive Medicine in action is itself an educator. The provision of a public water-supply has been known to raise the moral standard of a village; the care of the infant and the school medical service have exerted an astonishing effect in the enhancement of responsibility and the deepening of human nurture. Hence there has been in the last twenty-five years a significant inter-reaction between public health and public education. I have little doubt that the extension of education is at the root of much of the national health development.

We cannot here discuss the ways of carrying out preventive methods, nor what part should be taken by Government, by the Local Authority, or by voluntary effort, nor yet what the results have been. The primary health need of a community must always remain *environmental*—housing, water, air, food, workshop, drainage, sewage treatment, and the removal of refuse and nuisances. The secondary need, secondary only because it must follow and not precede an appropriate environment, must always be the *personal nurture*, education, and health of the people themselves, a nurture which begins nine months before birth and is continued to the end of life—eugenics, the care of maternity and infancy, child welfare, a school medical service, the defences against great infections or deficiency impairments, an industrial health service, a national health insurance, artificial immunity, international health co-operation, and always research into the unknown.

The results of this sort of statecraft have indeed been profound. It has ensured the survival, and increased the capacity, of the English people. Some of the methods are as old as mankind, others are of recent adoption, but together they have within a century extended the expectation of life at birth by seventeen years, and have postponed the expectation of death at all ages below sixty years.

But we must beware of prophecy, and neither ask nor expect such uniform development in future, remembering always two things. *We cannot often do what is best*, for the ideal is always beyond us, and our ignorance remains greater than our knowledge. Only an educated people is an effective people, and discipline is necessary to education. But we must be content with what is practicable, remembering that magic, superstition, and empiricism are still with us, and are deep rooted. Nor must we overlook the lesson of experience that *wise governance cannot as a rule exceed the assent and consent of the governed.* For in England public opinion is enthroned; habit remains second nature; practice is held to be better than theory; the impulse to good government and just administration is almost an instinct of the character of the people; and religion, coming out of a long past, has still its ancient power. At the end of his great book on *English Sanitary Institutions* (1890) Sir John Simon says, with significance, that reliance should still be placed upon the strength of the people for self-help, and upon the solicitude of the community for the welfare of its weaker members. Altruism and kindliness of man to man, combined with foresight, true economy and common sense, are among the forces which can most wisely apply the verities of the science and art of Preventive Medicine to the needs of men.

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